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**The Scientific and Social Construction of Post-World War II US Public Health
Guidelines for Physical Activity: 1948-1996**

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Submitted for the degree of Doctor of Philosophy (DPhil)

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Dissertation Summary

Public health guidelines for (leisure time) physical activity evolved in the United States from scientific research which began in Britain and spread to North America during the second half of the 20th Century. This dissertation examines the guidelines' scientific and social construction. Research questions centre upon what has become known as the 'threshold-intensity vs volume-energy expenditure debate': Is a minimum intensity of physical activity necessary to achieve significant beneficial health outcomes? Or can that effective 'dose' be achieved by accumulating a sufficient total volume of expenditure (kcal) -- regardless of its intensity?

The research questions are:

1. Why were public health guidelines switched from a focus upon vigorous intensity to moderate intensity, and was the science base sufficiently sound and uncontested to justify that switch on scientific (and social scientific) grounds?
2. Why were the guidelines so focused on cardiovascular disease (CVD) to the relative exclusion of other health outcomes?
3. Did a small, influential group of investigators play a disproportionate (anomalous) role in shaping the 1996 US Surgeon General's Report on Physical Activity and Health?

Conclusions: The US Surgeon General's Report switched public health focus from vigorous to moderate intensity activities on a proclaimed "emerging consensus" of scientific evidence. However, the science base remained complex and contested. This 'consensus' was, in large measure, socially constructed by a small group of investigators who had gained influence within the American Heart Association, the Centers for Disease Control and Prevention, the National Heart, Lung and Blood Institute, and then the very taskforce selected to write the Report.

This dissertation explores a new and relevant area of 'Regulatory Science' given current interest in sedentary lifestyles and illness, not least cardiovascular disease and obesity. Anomalies in scientific interpretation and policy making arose not from financial considerations, but primarily from motives of altruism and professional status.

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature_____

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Glossary of Abbreviations, Acronyms, and Terminology

Abbreviations (Journals and Publications)

AmJ Card	American Journal of Cardiology
AmJ ClinNutr	American Journal of Clinical Nutrition
AmJ Epid	American Journal of Epidemiology
AmJ PubHealth	American Journal of Public Health
AmJ Epid	American Journal of Epidemiology
Ann Behav Med	Annals of Behavioral Medicine
Annu Rev Nutr	Annual Review of Nutrition
Arch Int Med	Archives of Internal Medicine
BMJ	British Medical Journal
Can Med Assoc J	Journal of the Canadian Medical Association
IntJ Epid	International Journal of Epidemiology
IJO	International Journal of Obesity
JAMA	Journal of the American Medical Association
J Am Coll Nutr	Journal of the American College of Nutrition
J Clin Epid	Journal of Clinical Epidemiology
J Med Ethics	Journal of Medical Ethics
J Nutr	Journal of Nutrition
MMWR	Morbidity and Mortality Weekly Report
MSSE	Medicine & Science in Sports & Exercise
NEJM	New England Journal of Medicine
NHLBI Bundle	National Heart, Lung, and Blood Institute documents obtained under a US Freedom of Information Act (US FOIA) request
Nutr Rev	Nutrition Reviews
Prev Med	Preventive Medicine
Soc Stud Sci	Social Studies of Science

USSG 1996	<i>Physical Activity and Health: A Report of the Surgeon General</i> (US Surgeon General's Report on Physical Activity and Health 1996)
USDHSS 2008	US Department of Health and Human Services <i>2008 Physical Activity Guidelines for Americans</i>
USDHSS AC 2008	US Department of Health and Human Services <i>Physical Activity Guidelines Advisory Committee Report, 2008</i>

Acronyms

ACLS	Aerobics Center Longitudinal Study
BEEB	Behavioral Epidemiology and Evaluation Branch (of CDC)
CDC	Centers for Disease Control and Prevention
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
EE	Energy Expenditure
LTPA	Leisure-Time Physical Activity
METs	Metabolic Equivalent (of Tasks)
MRC	Medical Research Council (Britain)
NHLBI	National Heart Lung and Blood Institute (of NIH)
NIH	National Institutes of Health
PA	Physical Activity
PCPFS	President's Council on Physical Fitness and Sport
RCT	Randomised Controlled Trial
VO₂ max	Maximum (or Maximal) Oxygen Uptake
(US) FOIA	United States Freedom of Information Act

Terminology

'Dose-Response'

The term 'dose-response' is used widely throughout this dissertation, not least because it became increasingly the common usage of scientific investigators and policy makers in the field. The measurement of the impact of 'physical activities' on human health is complex – and arguably far less straightforward than, for example, the measurement of precise chemical compounds (pharmaceuticals) or surgical procedures. The 'dose' consists of at least four characteristics: the mode or type of activity (aerobic, anaerobic, resistance) combined with the intensity, duration and frequency of the activity. Most commonly in the literature examined in this dissertation the human 'response' to the 'dose' was either a reduction in heart attack incidence and/or fatalities in the cohort studied, or similarly, in all causes of death ('all-cause mortality').

Axes, and Curve Shapes

Much of the data analysed here come from scientific studies (and particularly from the earlier ones) where the data were presented by the authors simply in numerical, tabular form. However, when the authors chose to present data in line graphs or histograms, the 'dose-response' was typically presented with the 'dose' along the horizontal 'x' axis, and the 'response' along the vertical 'y' axis. That convention is repeated here when tabular data have been re-cast in histograms and line graphs.

'Threshold Dose'

Investigators in the field also generally used terms in a fairly uniform way to describe the shape of the curve delineating the 'dose-response' they described. First, the term 'threshold-dose' in this context describes the concept that the 'response' (for example in heart attack mortality) along the 'y' axis is absolute (nil or zero) until a high enough 'dose' -- a precise threshold of intensity of energy expenditure (measured in kcals/min) is reached and plotted along the 'x' axis. That convention too, is kept. This contrasts with might be described as a 'relative threshold' where the 'dose-response' is discontinuous – that is where the gradient is not constant but changes, for example, from a relatively modest slope to a markedly steeper one.

'Concave Curvilinear'

Any concept of such a 'relative threshold' appears to be absent from this literature. However, what is described (and again repeated here) is the concept of a 'concave curvilinear' shape of 'dose response'. In this case, the 'response' along the 'y' axis to, say, all-cause mortality is initially swift, dramatic and highly significant with an initial small increase in the 'dose'-- for example fitness level, plotted on the 'x' axis. However, each subsequent increasing dose is not matched by an equal 'response' – along the 'y' axis where the mortality rate fall continues much more slowly, resulting in a 'concave curvilinear' line which becomes asymptotic along the 'x' or 'dose' axis.

'Linear'

The most common 'dose-response' in the literature was found to be 'linear' – the plausible, and unsurprising concept that the 'response' (for example, reduction in heart attack mortality) along the 'y' axis falls steadily and in roughly equal measure to each increasing 'dose' (for example, an increased weekly total volume of energy expenditure measured in total kcals/wk) plotted along the 'x' axis.

'Intensity'

The 'intensity' of energy expenditure is broadly measured in two distinct ways in the literature: Either in relative (individually internal) or absolute (external) terms. Relative intensity is most commonly measured as a percentage of each individual's maximum ability to take in and use oxygen – the common acronym being: VO_2 max. Thus 60% VO_2 max (typically described as the onset of 'vigorous' intensity activity) will differ with each individual's cardiorespiratory fitness.

Absolute intensity is most commonly measured either in kcals/min of energy expenditure, or in multiples of basic or resting metabolic rate, with the common acronym being: METs (metabolic equivalents of tasks). Thus resting metabolic rate is given the value of 1 MET while, for example, running at 5 miles mph has been assigned a value of 8 METs (8 x resting metabolic rate) by the universally accepted compendium. (**Ainsworth et al 1993 and 2000**) But even these 'absolute' or external measures are relative to the extent that, in weight bearing activities, heavier people will expend more kcals/min doing the same task as lighter individuals. Equally, resting metabolic rates differ from individual to individual for many reasons (**James and Schofield 1990**). As has been said, measuring 'physical activity'

reliably and accurately is not easy and this imprecision dogs both the discipline, and analysis of it.

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Authors	Study Type	Cohort	Objective/Design	Outcomes	Main Results
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Morris et al 1953	Cross sectional	31,000+ male London busmen	Sudden cardiac death rates drivers/conductors	Conductors <½ death rate of Drivers	PA protects against cardiac deaths
Morris and Crawford 1958	Cross sectional	3,800 UK male non-cardiac deaths/necropsy	Comparison by 5 social classes of myocardial fibrosis	Linear fall highest social class to lowest	Manual work protects against heart disease
Taylor et al 1962	Cross sectional	190,000+ male US railroad workers	Cardiac death rates of clerks, switchmen and sectionmen	Linear fall with increasing manual labour	Manual work protects against cardiac death
Paffenbarger et al 1970	Cross sectional	3,200+ US 'long-shoremen'	Cardiac risk factors, and death rates among More/less active dockers	Significant rate falls for most risk factors among more active	PA protects against most risk factors and CHD death rates
Leisure Time Physical Activity Studies (LTPA)					
Morris et al 1973	Case control follow-up	16,000+ UK male civil servants	Heart attack protection from LTPA: intensity/ volume v controls	Heart attack rate <½ among 'vigorous' men compared to controls	Only 'vigorous' LTPA protective against CHD
Paffenbarger et al 1978	Longitudinal prospective follow-up	16,000+ Harvard alumni	Heart attack protection from LTPA 'index of EE activities'	Heart attack risk inverse to EE. 'Strenuous sports' enhance effect	Volume and intensity EE both protective against CHD

Authors	Study Type	Cohort	Objective/Design	Outcomes	Main Results
Morris et al 1980	Case control follow-up	17,000+ UK male civil servants	Heart attack protection from LTPA: intensity/ volume v controls	Heart attack rate <1/2 among 'vigorous' men compared to controls	Only 'vigorous' LTPA significantly protective against CHD
Paffenbarger et al 1986	Longitudinal prospective follow-up	16,000+ Harvard alumni	All-cause mortality protection from LTPA 'index of EE activities'	Mortality risk inverse to EE. 'Vigorous sports' significant inverse effect	Volume and intensity EE both protective against all-cause mortality
Leon et al 1987	Longitudinal prospective follow-up	12,000+ US men all 'high risk' CHD	Heart attack protection from moderate intensity LTPA	Heart attack deaths <1/2 moderate active/sedentary Most active/little > benefit	LTPA/fitness risk curve 'concave curvilinear'
Slattery and Jacob 1988 (Taylor's data)	Longitudinal prospective follow-up	3,000+ US railroad workers	Cardiac death protection by physical fitness (heart beats/min)	Linear reduction cardiac deaths with higher fitness at baseline	Fitness protection attenuated by CVD risk factors
Slattery et al 1989 (Taylor's data)	Longitudinal prospective follow-up	3,000+ US railroad workers	Cardiac death protection from LTPA taken by questionnaire	Linear reduction cardiac deaths with higher kcals/wk LTPA	LTPA protection attenuated by CVD risk factors
Ekelund et al 1988	Longitudinal prospective follow-up	3,000+ US males	Cardiac death protection by quartile/ physical fitness (heart rate)	Linear reduction cardiac deaths with higher fitness at base line	Lower fitness associated with higher death risk from CHD/CVD

Authors	Study Type	Cohort	Objective/Design	Outcomes	Main Results
Blair et al 1989	Longitudinal prospective follow-up	10,000+ US men 3,000+ US women	All-cause mortality protection by quintile/fitness (heart rate)	All-cause deaths $\approx \frac{1}{2}$ from least fit quintile to next quintile	Fitness risk curve 'concave curvilinear' less gain > fitness
Morris et al 1990	Longitudinal prospective follow-up	9,000+ UK male civil servants	Coronary attack/death rates by 'intensity' of LTPA by questionnaire	Coronary attack/death rate $> \frac{1}{2}$ for 'vigorous' men than others	Threshold intensity less strict especially for older 55+ yr men
Shaper and Wannamethee 1991	Longitudinal prospective follow-up	7,000+ UK men from GP surgery lists	Coronary attack/death rates by reported LTPA score	Coronary attack/deaths \approx inverse linear with higher score/asymptote	Vigorous activity 'beneficial' not 'essential' protection
The Randomised Controlled Intervention Studies					
Duncan et al 1991	Randomised controlled trial (RCT)	102 premenopausal US women 59 completed trial	Effect of walking speeds on cardiorespiratory v CVD risk factor outcomes	> walking speed linear with cardiorespiratory but not >HDL level	Vigorous intensity not necessary for 'meaningful' > HDL
King et al 1991 and 1995	Randomised controlled trial (RCT)	160 US women 192 US men aged 50-65	Effect of 3 exercise types mod/vig lifestyle vig group on cardio HDL adherence	Mod lifestyle > HDL outcome. Vig lifestyle > cardio, > adherence	Authors focus on mod lifestyle > HDL

Authors	Study Type	Cohort	Objective/Design	Outcomes	Main Results
Later LTPA Studies					
Paffenbarger et al 1993	Longitudinal prospective follow-up	10,000+ Harvard alumni	Changes in LTPA and other lifestyle choices with all-cause mortality	Starting mod-vig LTPA 23% reduction in risk	Even small amounts (<1 hr/wk) significantly reduce mortality risk
Lee et al 1995	Longitudinal prospective follow-up	17,000+ Harvard alumni	Effects vigorous and non-vigorous intensity LTPA on all-cause mortality	Vigorous but not non-vigorous significantly reduces all-cause mort	Main finding repeated but moderate LTPA advocated for sedentary
Blair et al 1996	Longitudinal prospective follow-up	25,000+ US men 7,000+ US women	Relation between cardio fitness and CVD mort within other risk factors	Cardiac death protection linear with > cardio-respiratory fitness	Focus on benefits of moderate fitness despite >fitness linear outcome

Chapter 1: Introduction

From 1948-1996 the scientific study of human physical activity emerged from its narrow focus on medical physiology (including the performance of elite athletes) to become a broad and front-rank public health tool on par with sanitation, nutrition, immunisation and tobacco smoking cessation.

This dissertation examines this transition and transformation of physical activity study and its practical application in the prevention, or at least reduction, of disease and promotion of positive health outcomes.

Its focus is principally on the development of physical activity science as applied to cardiovascular disease and the subsequent development of United States public health guidelines for physical activity aimed not only at doctors and other health professionals – but increasingly at the general public in the United States and elsewhere. It culminates with an examination of the construction and presentation of the US Surgeon General's first extensive, and widely influential report on physical activity and health published just before the Atlanta Olympic games in 1996.

The central questions are: Did these post World War II investigations and subsequent recommendations in the field of physical activity and public health derive exclusively from scientific considerations, or were the scientific literature and subsequent public health recommendations (in their choice, design and interpretation) also influenced by 'social' factors – and if so what were these 'non-scientific' influences and why did they come about?

A conceptual framework for tackling this and related research questions is developed in the next chapter (Chapter 2), first by comparing and then choosing among competing epistemological accounts of the nature of science and corresponding analyses of the role of science in public policy-making. Second, some relevant theoretical concepts from Popper, Merton and Kuhn are reviewed. Third, the subject and scope of this dissertation are located within the field of 'Regulatory Science', a concept that is characterised and justified. Several relevant case studies from the science policy literature are then briefly reviewed, analysed, and categorised into a theoretical framework.

In Chapter 3, the research questions are elaborated in the light of the analytical framework, and the research methods are outlined. These include an explanation of how the chosen theoretical tools (Realist Constructivism and Actor-Network Theory) and the methods of political Sociology of Scientific Knowledge (pSSK) may be

deployed to answer the research questions. Finally, the sources of documentation and information, including interviews with key investigators and policy makers are listed.

In Chapter 4 examination of the chronological and thematic evolution of the scientific literature and debates then begins with the early post-war occupational activity studies of Jeremy Morris, Henry Taylor and Ralph Paffenbarger – all conducted with white male cohorts. The chronological narrative then turns in Chapter 5 to the first leisure-time physical activity studies in the 1970s pioneered by Morris, and followed by Paffenbarger – again, conducted exclusively with white male cohorts. In Chapter 6 the next important development to be explored is a landmark workshop in 1984 which marked the first successful attempt to bring the study of physical activity into the US public health movement.

This new, broader focus on public health coincided with a new ‘moderate/volume’ hypothesis propounded by a group of American investigators, led by Steven Blair, who sought to challenge the existing orthodoxy that a minimum ‘threshold intensity’ of aerobic activity, as proposed by Morris, the British investigator, was the key element in disease protection and health promotion. This debate, conducted in a series of epidemiological and intervention studies between 1986 and 1995 is examined in depth in Chapter 7.

These academic and scientific debates simultaneously shaped and informed a parallel public health debate which emerged in a series of polemics, workshops, position papers and conferences between 1990 and 1996 that were increasingly influenced by Blair and his close associates both in academic circles and within the American Heart Association, the American College of Sports Medicine, and the US government’s National Institutes of Health, and Centers for Disease Control and Prevention. These events, too, are explored in some depth in Chapter 8.

In Chapter 9, the seminal *Physical Activity and Health: A Report of the Surgeon General* (for simplicity to be referred to in this study as: *US Surgeon General’s Report on Physical Activity and Health 1996* and cited as **USSG 1996**) is subjected to textual scrutiny to see how its key analyses and public health recommendations were themselves heavily influenced not only by the debates described above, but also by the inclusion of Blair and his associates into the key editorial positions of influence on the Report’s panels of writers and editors.

Finally, in Chapter 10 the successful drive to promote the new ‘moderate/volume’ hypothesis as public health policy – to make it the new ruling orthodoxy – is next examined and analysed, using the techniques of both pSSK and Actor-Network Theory to explore the apparently consistent and anomalous ways that the scientific evidence base was interpreted, and sometimes distorted, omitted, and apparently, ignored in order to construct ‘an emerging consensus’ of scientific opinion in its favour.

1.1 Context

Before turning to the ‘theoretical considerations’ of Chapter 2, it is important to put the subject of this dissertation in the contexts of: its place within science policy literature; its possible value and particular relevance to public health workers and policy makers; and to social historians interested in the post World War II development of the study of human physical activity, its epidemiology, and its application as an important instrument in public health.

1.1.1 Science Policy: Location within ‘Regulatory Science’

The development of governmental guidelines for leisure time physical activity sits as comfortably within the public health arena as do more familiar goals such as formation of dietary and nutritional guidelines, and policies to curb tobacco smoking and reduce the incidence of infectious diseases. All lie within the realms of Regulatory Science where often quite quick and contentious decisions must be made involving complex and often disputed scientific evidence, and affecting the well-being and lifestyles of large populations. It is hoped, however, that scholars of science policy will find the subject of this dissertation particularly useful for at least two reasons. First, as far as I am aware, the post-World War II scientific literature on the study of physical activity and health and its role in shaping public health guidelines has not previously been explored and documented in any depth. To that extent it may be a ‘new’ field, or at least one that has been under-investigated.

Second, most ‘case studies’ previously explored in the realms of ‘regulatory science’ have involved social influences which are typically ‘external’ to the scientific protagonists and involve ‘macro-economic’ financial elements. Few any longer doubt, for example, that the tobacco, food, and pharmaceutical industries all attempt to protect their products and profits by employing ‘expert scientific evidence and opinion’ to their own advantage - and that campaigners who oppose them, while on smaller budgets, use similar tactics to combat these and other commercial interests. For example, Marion Nestle and others have closely examined the battles that have been, and

continue to be fought between public health nutritionists and lobbies within the food industry over dietary guidelines frequently and regularly issued by the US government since the 1970s when advice switched from guidance about nutritional deficiencies to warnings about dietary excess. **(Nestle M 1994 p 713)** (Nestle's work in this field is briefly explored further in Chapter 2). The continuing conflict in nutrition policy was also characterised by David Kessler in 1995 when he was director of the US Food and Drug Administration:

“Until quite recently, domestic regulatory efforts in the area of nutrition policy were focused on achieving and sustaining this high level of safety and availability. Today, however, epidemiologists, clinical investigators, and nutrition scientists have shifted attention to linkages between certain dietary practices and the risk of chronic, degenerative diseases, including hypertension, coronary heart disease, cancer, stroke and diabetes. As a result, problems associated with overnutrition, high consumption of fats, and low intake of fruits, vegetables, and grains have gained urgency. The need to identify and implement public policies to combat ‘nutritional diseases of affluence’ and to promote good nutrition practices is now widely recognised.” **(Kessler D 1995 p xiv)**

Unusually, preliminary evidence suggested that the social influences which affected the development and alteration of US government physical activity guidelines in the late 20th century may have been neither ‘external’ nor ‘macro-economic’. In vernacular terms, the motive may not have been money. The social influences in this study may have been more subtle, indeed largely well-meaning, and thus more rare, and particularly interesting. Some way into this research I was guided to the fine work of Karin Garrety and her exploration of how the ‘cholesterol hypothesis’ of Ancel Keys and his colleagues gained the ‘warranted authority’ of medical fact in spite of highly contested evidence which was both incomplete and contentiously interpreted. The parallels with this study have been illuminating. **(Garrety K 1997) (Keys A 1952)**

1.1.2 Public Health: Sedentary Living and Morbidity

Public health workers and policy makers, as well as modern social historians may also find the material and its analysis relevant, not least because it tries to trace the academic study of physical activity from its early post-World War II occupational (manual labour) investigations through to its gradual emergence as an important public

health discipline with a focus on improving leisure-time sedentary lifestyles. That pursuit began with a desire to demonstrate the benefits of physical activity in heart disease risk reduction, and then in other major diseases. But it has become even more relevant today because of the increase in sedentary lifestyles and the current ‘obesity epidemic’ in the Americas and Europe which was only just becoming widely evident in 1996, the year of the US Surgeon General’s Report, and the end-year of this dissertation.

1.1.3 The 20th Century Public Health Movement: from contagion to chronic diseases

The development of public health policy appears to have come from rather different roots in the United States as compared to those, for example, from Britain. While practitioners and policy makers in both countries were, in the early decades of the century, still concerned with contagion and sanitation, Virginia Berridge argues that since World War II in Britain focus has shifted from ‘environmentalism’ to ‘individualism’:

“The shift can be broadly characterised as a move away from environmentalism towards a greater degree of individual responsibility for the maintenance of health. This emphasis on the ‘personal’ informed a number of developments in health policy.” **(Berridge V 1999 p 48)**

She argues, for example that in the 1950s ‘environmental’ issues such as mass vaccination for tuberculosis and polio as well as efforts to reduce industrial and urban smoke pollution gave way to single issues on the “deregulation of personal life” such as the contraceptive pill, abortion and more relaxed attitudes toward homosexuality. **(op cit p 52)**

There can be no doubt, however, that public health policy in both countries was, and remains, driven by a ‘political and social sub-text’ of tension between ‘conservative’ and ‘progressive’ forces. For example, in the next chapter (Chapter 2) the examination by Smith and Nicolson of the early 20th century ‘vitamin debate’ in Britain reveals a wider class struggle framed by the biochemical debate over vitamin D and rickets. **(Smith and Nicolson 1989)**

However, in her analysis of the development of public health in the United States, Elizabeth Fee argues even more emphatically that the public health movement was shaped and driven politically by the need to heal the rift, or at least bridge the gap,

between the rapacious entrepreneurial capitalism worshiped by the American Right, and what was then seen as the dangerous rise of Socialist tendencies not quite exterminated after the transatlantic progress of the Founding Fathers:

“Politically, public health reform seemed to occupy middle ground between the cut-throat principles of entrepreneurial capitalism and the revolutionary ideas of the socialists, anarchists and utopian visionaries.” **(Fee E 1994 p 234)**

And who should be the philanthropic force to build this ‘public health bridge’ between capitalism and socialism? None other than the Rockefeller Foundation (funded from oil wealth) which in 1916 funded the first School of Hygiene and Public Health at Johns Hopkins University (where Fee is a Professor) and went on to finance many other similar institutions.

1.1.4 A Brief History of Physical Activity and Health

1.1.4.1 Introduction

The impact of physical activity on health outcomes has been known and cited since ancient times (Hippocrates, Galen). **(Blair et al 1992 p 101, 120 and Duncan et al 1991 p 3299, Paffenbarger et al 2001 pp 1184-85)** The changes to human diet and energy expenditure from ‘stone age’ hunter-gatherers, through to the early agriculturalists have also been examined by anthropologists and evolutionary biologists in detail. **(Eaton et al 1988)** The 19th century also saw the advent of physical education in American colleges and in Britain the beginning of organised ‘games playing’, most notably at the elite boarding schools in Britain. But it was not until the early years of the post World War II era, that serious medical and epidemiological study of physical activity on large populations was undertaken to investigate the ability of physical activity to influence rates of morbidity and mortality across a wide range of illnesses and conditions (health outcomes) – notably the cardiovascular diseases, and in more recent years some cancers, type 2 diabetes, and morbid obesity. **(Paffenbarger RS 2000 p 421, USSG 1996 p 16)**

Earlier in the twentieth century the study of physical activity had been confined to a more narrow type of scientific study. One important goal was the training of elite athletes (and race horses) whose biomechanical methods of motion, as well as related energy expenditure, needed to be measured intensively to establish race winning results. **(personal communication with WPT James 2000)** The second key area of

investigation was a much more mundane, but hugely important and cost-conscious commercial business: the need to determine the energy expenditure of armed servicemen and of key workers such as agricultural labourers and miners, especially during wartime, to establish how many or how few calories (energy intake) would be needed to balance their enormous energy expenditure in order to keep them alive, reasonably healthy, and therefore productive. In the United Kingdom much of this latter investigation was conducted by the Medical Research Council (MRC). **(see for example Cathcart et al 1927; Cathcart and Murray 1932; Cathcart et al 1935)** While the primary focus was almost invariably upon nutrition, energy expenditure was also considered in considerable depth. Typical of such studies was one from the MRC's Committee upon Quantitative Problems in Human Nutrition and its 1924 report on miners. It observed:

“As the fuel value of a food-stuff can be converted into terms of heat units, so the energy expended by the organism in the mere act of living, or in the performance of external work, can be state also in terms of heat units....The state of health and the state of nutrition of the subject, the nature of the diet, &c. [sic], are all influential, but the most potent factor in increasing the metabolic rate is, undoubtedly muscular work, and the extent of the increase is more or less proportional to the amount of work done.” **(MRC 1924 pp 8,11)**

Prior to World War II, efforts in public health science and policy were still highly focused upon malnutrition and on sanitation and contagion. Infectious diseases, which had low association with levels of physical inactivity and a high association with poverty, poor sanitation and inadequate nutrition, were still a major cause of severe morbidity and mortality. **(see for example Mackenzie L 1924)** In 1920, 11 major infectious diseases accounted for more than 60 percent of all mortality in the United States, whereas the three major chronic conditions (heart disease, cancer, and stroke) together accounted for just over 20 percent. **(Beaglehole et al 1993 p 84)** Despite their increasing incidence, heart disease, stroke, and cancer were comparatively less investigated as major public health issues. Unhealthy weight gain was least studied, simply because few other than the most affluent could afford to be sedentary and regularly to consume excessive, energy dense food. Indeed, The Great Depression in the 1930s and War-time food scarcities in the United States and rationing in Britain meant that avoiding under-nourishment in civilian and military populations was of primary concern. Ancel Keys, an American who would play a leading role in post-war investigations

of diet, and to a lesser extent, physical activity, was credited with designing the primary food packs carried into battle by US soldiers. They became known as 'K' rations, and were reputedly named after him.

1.1.5 Coronary Heart Disease: the post-war 'epidemic'

The perception of public health priorities changed rapidly in the aftermath of World War II. By 1940, the 11 major infectious diseases together accounted for only 20 percent of all US deaths, as improved sanitation and the discovery of powerful anti-microbial drugs (sulpha, penicillin and then later classes of antibiotics) diminished the risks posed by many contagious diseases. In contrast, by 1940 the three major chronic conditions, led by heart disease, were accounting for 40 percent of deaths, a complete inversion of the position in just two decades. **(op cit p 84)** After the war ended, therefore, public health emphasis would shift to the aetiology, treatment and prevention of non-infectious medical conditions, most notably the cardiovascular diseases (coronary heart, and arterial disease including stroke) followed subsequently by cancer. In public health terms, the importance of sufficient physical activity to reduce the risk of cardiovascular and other non-communicable diseases (including unhealthy weight gain) was only just emerging and would not become an important public health issue for several decades -- even in the United States where sedentary living and inexpensive, energy dense food would become the norm far earlier than in Britain and the rest of Europe. **(personal communication KE Powell, Atlanta, Georgia May 2007)**

However, prior to the post World War II period and until relatively recently, investigation of the importance of physical activity would have little, if any, impact on the field of public health. In their 2006 edited anthology of *Silent Victories* in public health Ward and Warren examine 10 categories of the history and practice of public health in America. **(Ward and Warren 2006)** Control of, and vaccination against infectious diseases are obvious chapter entries including, for example, occupational disease, family planning, smoking, cardiovascular disease and nutrition. Indeed, nutrition, in addition to its own chapter, has additional input in the chapter on cardiovascular disease. As will be seen in Chapter 6, it was not until the mid 1980s that physical activity began to take an important role in the US public health movement, although the Framingham Heart Study, discussed below, would become an important pre-cursor in its development.

1.1.6. The Framingham Heart Study: 1948

The first important US government initiative in the search for the causes and prevention of the cardiovascular diseases came in 1948 when the National Heart Institute (now the National Heart, Lung, and Blood Institute) established the *Framingham Heart Study*. **(CDC 1999b)** Preventive public health epidemiology was then still in its infancy when more than 5,000 men and women, aged 30-62, from Framingham, Massachusetts agreed to be selected for the longitudinal cohort study which continues today in its third cohort generation (the grandchildren of the first). In line with the American Heart Association and other investigators, the Framingham epidemiologists first identified cigarette smoking as a major risk factor in cardiovascular diseases, quickly followed by elevated serum cholesterol and high blood pressure. Concerns from the Framingham study about physical (in)activity and unhealthy weight gain (obesity) were not published by its investigators until later. There appear to have been at least four important reasons for this emphasis: First, occupational levels of physical activity remained high and obesity rates remained low in the first decades of the Framingham study. Second, a succession of observational studies, from Framingham and elsewhere, were subsequently to show that while physical inactivity and excessive weight were significant risk factors in heart disease, the significance and incidence of cigarette smoking, and diet and nutrition-related hypertension and elevated serum cholesterol were measurably greater. **(Paffenbarger et al 1978 and Paffenbarger et al 1986)**. Third, the debates and battles over the links between saturated fats and tobacco were fiercely contested by the commercial lobbies and campaigning organisations that sought either to contest or confirm the associations. Such battles were to make headlines in public health much more easily than physical inactivity and unhealthy weight gain. **(personal communication with T Bazzarre, Princeton, New Jersey May 2007)**

Fourth, during the 1950s in the United States Ancel Keys led investigation into the role of diet (and particularly saturated fats and dietary cholesterol) in the rapidly growing heart disease epidemic. In Britain in the same period, Richard Doll began to examine the role of tobacco smoking in heart disease and then lung cancer. Both men were powerful communicators with the public through the media. **(CDC 1999a)**

1.1.7 Jeremy Morris

Less well known outside his academic community was, and remains, the pioneering work of Jeremy Morris (who died aged 99 in October 2009) in the parallel field of physical activity and health. Morris, a Liverpoolian who trained in London and Glasgow, was the first post-World War II investigator to focus upon the role of physical activity in coronary disease reduction and prevention. **(Berridge V 2001 p 1141, Paffenbarger et al 2001 p 1185-88)** A physician, with a keen and life-long interest in public health and social justice, Morris' critical insight was to ask, and then to test in British population terms, whether there could be any association, and indeed causation, between the rise in heart disease and a lack of, or reduction in, the frequency, intensity and duration of physical activity. This was, at a time of heavy manual labour, relatively little mechanisation, and fewer, sedentary leisure activities, a most unorthodox hypothesis: that insufficient physical activity might be detrimental to human health in ways quite unrelated to the problems of balancing energy intake and expenditure to prevent malnutrition. It was an insight that gradually established the public health importance of the scientific study of physical activity, beginning with the prevention and management of heart disease. In subsequent post war decades, the public health establishments in the United States and Europe began also to discover the importance of physical activity in the prevention of some cancers and then more recently, in the prevention and control of type two diabetes (DM2), unhealthy weight gain, and morbid obesity.

In the early 1950s, Morris' investigations were entirely novel. Most adults and children in Britain – naturally and out of necessity – incorporated considerable physical activity into their daily lives, most often from: walking or bicycling to work or school (in the absence of affordable motor cars or available public transport), from their manual occupations, from domestic manual labour, and from their inexpensive sports activities. Morris' occupational studies were to be followed in the United States, most notably by Henry Taylor (a colleague of Ancel Keys) and by Ralph Paffenbarger. Perhaps most crucially from a public health perspective, Morris switched his attention from occupational to leisure-time studies in the early 1970s, aware that rapid mechanisation in both transport and workplaces (including homes) were together causing a swift diminution of regular occupational energy expenditure. It was also perhaps no coincidence that this same period saw the production of the first public health guidelines for leisure-time physical activity (LTPA) in the United States.

By contrast, the importance of public health guidelines and advice about diet and nutrition had become apparent much earlier, at least by the beginning of the 20th century. **(Welsh S 1994, Kritchevsky D 1998, Calloway CW 1997, Kessler DA 1995)** Indeed, by the 1970s there was a 'plethora' of such dietary reports in the United States, mostly from US Government departments. For example, in just four years between 1977 and 1980 ten important American dietary reports were published **(McNutt K 1980, 'McGovern Report' 1977)**. The first widely recognised and disseminated public health physical activity guidelines in the United States (from the American Heart Association) were not published until 1972, and until 1995 almost all leisure-time physical activity guidelines in the United States came from non-governmental bodies. **(USSG 1996 p 23-27)** Public health guidelines for physical activity may not have existed at all, had it not been for the pioneering work in Britain of Jeremy Morris, and to his colleagues and competitors in the United States to which we shall turn in Chapter 4.

Chapter 2: Theoretical Considerations

2 Introduction

This chapter examines the theoretical considerations that *prima facie* may serve to underpin this dissertation, and thereby provide a framework that will assist in answering its central research questions.

Publication in 1996 of the first US Surgeon General's Report on Physical Activity and Health marked a milestone in the perceived role of leisure-time energy expenditure as a crucial part of disease prevention and health promotion in the Western World. It also ushered physical activity, its policy exponents, and its scientific investigators for the first time into the front rank of Western public health promotion along-side sanitation, immunisation, nutrition and smoking cessation.

Strikingly, the Report's overwhelming thrust, and its specific public health guidelines effectively dismissed previous evidence, assumptions and advice which had emphasised the importance of 'vigorous' intensity activities – particularly in the prevention of cardiovascular disease. This prevailing hypothesis of a 'minimum vigorous intensity threshold' – and indeed the need to do any vigorous activity at all, was rejected in the 1996 Report and replaced with new advice that specified that the 'total volume' of energy expenditure, achievable at even low to moderate intensity, was the key to disease reduction and prevention – and thus the new primary tool and recommendation in public health.

On what grounds, for which reasons and, indeed, under what assumptions did the taskforce assembled for the Surgeon General take this decision to switch public health advice from a 'vigorous threshold' of intensity to 'total volume' of energy expenditure – with intensity of little or no importance? Was there, for example, abundant and sound new evidence to support this important shift in public health recommendations?

It appears evident that the scientists and policy makers who made up the task force were attempting, or believed they were attempting, to apply strict standards of scientific evaluation to their deliberations and decisions. While the term 'evidence based

assessment' was not in common parlance in the mid-1990s, the task force participants frequently used the expression 'dose – response' to indicate their growing belief that they were becoming increasingly successfully in their attempts to measure the health impacts (as a 'response') delivered by various aspects of physical activity (mode/method, intensity, duration and frequency) – comprising the 'dose' of energy expenditure recommended (see also 'Dose-Response' in Glossary of Abbreviations, Acronyms and Terminology).

The Surgeon General's Report claimed that a scientific consensus was emerging that physical activity did not need to be vigorous to have substantial health benefits. Yet even a preliminary examination of the literature would suggest that evidence, opinions and conclusions about the precise 'dose – response' of physical activity on human health outcomes appeared incomplete, frequently imprecise and indeed, at times, conflicting.

The decision, therefore, by the taskforce to declare an 'emerging [moderate] consensus' amidst such apparently conflicting evidence and lack of genuine consensus on intensity and duration will need extensive analysis and considerable explanation. It will therefore be important to consider whether the reasons for this apparent anomaly may be found in the role of science in policy making – or more precisely the role of scientific evidence and experts in the policy making process. This is particularly important in such a politically sensitive area as public health advice, delivered at a time of growing concern about avoidable 'lifestyle pathologies', such as physical inactivity and sedentary habits as important causes of illness, not least cardiovascular disease, some cancers, but also of unhealthy weight gain (obesity) which can be seen both as a lifestyle pathology, and as an illness in itself. The role of scientific evidence and experts in science-based policy making will be reviewed in some depth later in this chapter after the characteristics of what is now known as Regulatory Science (of which public health is a subset) are examined.

Further, it will be important to examine whether the taskforce's judgements, decisions and recommendations were influenced not solely by the scientific evidence, but by their choice and interpretations of it – and, in turn, whether those choices and interpretations may have been socially influenced and whether their decisions were, in part, socially constructed. Finally, if the decisions were 'hybrids' of both scientific and non-scientific considerations, then it is hoped that the non-scientific elements and influences can be disentangled and separated from the scientific considerations.

What analytical framework, therefore, appears to be potentially the most useful to examine this topic, and to answer the research question(s); to analyse any apparent anomalies, and to help explore the hypothesis that the 1996 guidelines may have been, at least in part, a social construct rather than a purely scientific document? To develop such a framework I will first review a range of theories concerning the epistemological status of scientific knowledge and its potential relevance to policy matters. The purpose of that discussion will be to identify a set of background assumptions that can frame this study. That discussion will then be complemented by a subsequent discussion of what might be referred to as ‘foreground’ theories that will themselves be used and tested in the empirical sections of this thesis. Thereafter, the distinctive nature of Regulatory Science, of which public health guidelines as a subset, will be considered. Finally, key case studies in the science policy literature will, for relevance, be categorised, examined and compared to create a ‘theoretical framework’.

2.1 Competing Epistemological Accounts of the Nature of Science and portrayals of science in policy making)

2.1.1 Logical Positivism

Logical Positivists such as Schlick, Neurath, Carnap and Ayer assumed that science is empirically verified and therefore certain and reliable – and above all uninfluenced by any social (non-scientific) factors, since science is derived from direct observation and experience. **(Hess DJ 1997 p 8) (Neurath et al 1955)** Moreover, they assumed that, when science is working properly, its practitioners (scientists) work in consensual harmony and are always objective (uninfluenced by social, cultural, economic or political forces) in their assessments of evidence by the process of verification **(Popper K 2002 pp 58-73, Hess DJ 1997 p 9-17)** They often routinely assumed that the only source of knowledge was empirical evidence, and that, if it was accurately reported it was self-evident and did not require to be interpreted. For all those reasons, and given the lack of certainty or consensus, and contests about the interpretation of apparently conflicting data sets, trying to analyse the development of physical activity guidelines in the USA in the mid-1990s from a positivistic perspective would not appear to be a promising approach.

Moreover, preliminary examination of the post-World War II literature, and contemporary reviews, on the impact of physical activity on cardiovascular disease and other health outcomes suggests that the policy decisions taken by the US Surgeon General's taskforce may not have been based solely on the scientific evidence. As Logical Positivism is inherently anti-constructionist – rejecting any social construction of scientific evidence, hypotheses or interpretations – it would appear unsuitable to the topic of this dissertation. The suggestion that the physical activity guidelines were entirely derived from and only from scientific evidence might be characterised in this context as a 'null hypothesis'; as such it will need to be given due consideration even though it seems *prima facie* to be implausible.

2.1.2 Fallibilism

Fallibilism might be described as a relatively 'liberal' version of 'Scientism', when compared to the austere 'Scientism' of Positivism and it might, therefore, appear to be a potentially more promising analytical framework than strict positivism. Fallibilists, such as J S Mill and K R Popper, accepted that science is fallible and so can be uncertain – hence the choice of 'fallibilism' as its name, and consequentially science may not be entirely consensual. **(Mill JS 1865)** In Karl Popper's influential version of fallibilism it further accepts that science can also be influenced in some but not all respects by social factors, most notably in the intuitive process of 'discovery' but not in the context of 'justification'. Popper argued that at the empirical level science should be consensual, though not necessarily at the theoretical level, but he rejected any suggestion of the social construction of the interpretation of evidence **(Popper K 1968 pp 7-8)**. It therefore appears that fallibilism may also be an inadequate analytical framework for the analysis of the construction of post World War II public health guidelines for physical activity.

2.1.3 Sceptical Social Relativism

In response to the limitations of what Thomas Kuhn saw as the historical inadequacies of Popper's stereotype of scientific behaviour, and other antecedent stereotypes, Kuhn developed his analysis in terms of the dominant role of scientific paradigms, each of which defines its own worldview, bodies of evidence, and methods of inquiry. Kuhn differentiated, moreover, what he referred to as 'normal science' -- in which paradigms are taken for

granted, but are extended and elaborated in their application -- from 'revolutions' during which one old paradigm is replaced by a new paradigm. **(Kuhn T 1962 pp 92-103)** Numerous commentators detected a key ambiguity in the argument of Kuhn's *Structure of Scientific Revolutions*, published in 1962, an ambiguity to which Kuhn responded in the Postscript to the Second Edition in 1969. While some interpreted Kuhn as having retreated in 1969 from 'radical sceptical relativist' towards a Popperian-type moderate version of scientism, many others such as Barnes, Bloor, Collins and Woolgar discounted that retreat in the Postscript and enthusiastically embraced a radically sceptical variant of social relativism, portraying science as if it were not just socially constructed, but socially constructed solely from social rather than empirical or scientific ingredients. **(Barnes B 1974, Bloor D 1991, Collins H 1983, 1994)** Taken to its extreme, the analytical framework of social relativism maintains, therefore, that "science is purely the product of external (social) factors misrepresented as if it were internally generated" **(personal communication with E Millstone 2002)**. That radical concept broadly adopts the position that the scientific actors and the social worlds they inhabit and operate within (often described as 'Actor-Network Theory') appear to play a crucial role in explaining scientific beliefs without necessary reference to the natural world itself. **(see for example, Latour B 1983 and Latour and Woolgar 1986)** Thus, the beliefs of scientists are essentially derived from, and explicable solely by reference to, social factors.

Even a cursory examination of the post World War II physical activity literature clearly indicates the growing availability of an important body of scientific evidence, albeit one with considerable knowledge gaps – and hence an extreme version of sceptical social relativism may be considered to provide an inadequate analytical framework for this dissertation. However, it will be interesting to explore whether, and if so, to what extent, the scientific investigation of the health impacts of physical activity – and the wider public health policy debate – were constructed and influenced by definable groups of investigators (such as those who were influential within the American Heart Association) which gave prominence and 'warranted authority' to the 'moderate intensity physical activity' human health hypothesis. Preliminary examination of this question strongly suggests that a small and cohesive group of investigators did play a highly influential role in policy making – both before and during preparation and publication of the US Surgeon General's 1996 Report. This important issue will be elaborated upon later in this chapter.

Given the limitations of both Positivist and Fallibilist versions of Scientism, which in epistemological terms are realist but anti-constructivist and the radically anti-realist versions of Sceptical Social Relativism, the problem addressed and research questions posed in this thesis seem to require a primary approach that is epistemologically both realist and constructivist. Or in simple terms, an approach is needed which fundamentally accepts the 'reality' of a body of observed scientific evidence, but which further accepts that this evidence base is inevitably open to the influence of human interpretation, often for a complex variety of reasons, and is therefore also deemed to be 'socially constructed'. Thus, an analytical framework which accepts the 'reality' of the material world and relevance of empirical scientific evidence, but which allows that definable 'social' forces (including the impact of strong personalities) may influence deliberations, interpretation and policy making, seems *prima facie* most appropriate for the topic of this dissertation. It is therefore to the social science school of Realist Constructivism to which we now turn.

2.1.4 Realist Constructivism and the Political Sociology of Scientific Knowledge (pSSK)

Whereas both the Positivists, and to a lesser extent the Fallibilists, seek to defend the empirical purity of science and scientists ('Scientism') against the intrusion, and confusion, of social influences, Realist Constructivists accept, and indeed assert, that science and technology are routinely constructed from both natural (scientific) and social elements and that these 'hybrid' constructs can be defined and, under certain conditions, disentangled or 'deconstructed' to distinguish and to describe the influence of these factors, both social and scientific. **(van Zwanenberg & Millstone 2000, Millstone EP 2004)** Furthermore, these social elements may be of particular influence and importance in 'regulatory' fields where science is used to underpin and give authority to policy decisions of economic, political and wider social importance.

Early proponents of this approach were Daryl Chubin and Sal Restivo **(Chubin and Restivo 1981 and see also Chubin DE 1981 and 1996)**: Along with others, Chubin and Restivo argued that many claims, discourses and judgements that purported to be purely scientific were, in fact, complex hybrids of scientific and non-scientific considerations.

Chubin and Restivo urged social scientists to become 'meta-inquirers' when investigating such debates. Each must act "...as a social critic and activist, one who must surmount the

advocacy of world views and the politics of self interested inquiry.” **(Chubin and Restivo 1981 p 62)** They argued, moreover that:

“Because values cannot be purged from reflexive analyses of science, they must be made explicit and applied to the investigation of policy questions. Once social analysts of science are shown to be as self-interested as those whom they study, they will not smugly define as irrelevant the cultural and social values that have normative or ethical implications. It is precisely the role of values that meta-analysts must introduce into the ‘interpretative’ science studies, and in the process, into science policy.” **(op cit pp 63-64).**

Chubin and Restivo can best be understood as having articulated a position that reconciles epistemological realism with an element of social constructivism. Realist Constructivism suggests, for example, that when examining and trying to make explicit the social elements which may have influenced the construction of post World War II physical activity guidelines, it will be helpful to attempt to make explicit the investigator’s own values and assumptions when making judgements and interpretations about the apparent anomalies, inconsistencies and uncertainties in evidence presented and the policy decisions taken.

2.1.4.1 Political Sociology of Scientific Knowledge (pSSK)

Within the wider analytical framework of Realist Constructivism lies the methodological tool that could be described as a Political Sociology of Scientific Knowledge (pSSK) – a method for analysing and dissecting science-based policy decisions which has been developed most notably by Jasanoff in the United States and by Ravetz, Wynne, and Millstone in Britain, some of whose work is examined later in this chapter. **(Jasanoff S 1987, 1990, Ravetz J 2001, Ravetz J 1986, Funtowicz and Ravetz, 1990, 1993, Wynne B 1992, Millstone EP 2004, van Zwanenberg and Millstone 2000)**

In the versions of pSSK developed, for example, by Ravetz and van Zwanenberg & Millstone, the approach focuses examination upon apparent ambiguities, conflicts and uncertainties in the scientific evidence base and further, where they exist, the anomalies that may lie in the various interpretations of that evidence. It encourages investigators to

examine whether non-scientific 'framing assumptions' may have played important roles not only in the selection of the evidence base, but also in those differing interpretations.

As will be argued below, an approach such as pSSK appears particularly promising in the examination of case studies within the science-based policy making orbit of Regulatory Science, and where, typically, the science base is often uncertain and contentiously debated, yet at the same time, of considerable public importance. From even cursory examination, it appears clear that the post-War construction of US public health guidelines for physical activity fits within this description.

It is further likely, given the apparent uncertainty of the science base, and the public health importance of the guidelines' construction, that several non-scientific (social) considerations may have played a crucial role in their formation. Once the scientific and non-scientific factors have been disentangled from such policy decisions, the political Sociology of Scientific Knowledge approach then seeks to enable the science policy investigator to make informed judgements about the relative reliability and credibility of competing claims that contest, and ultimately form, regulatory decisions. **(Frickel and Kelly 2006 pp 4-26)**

Thus, the pSSK approach provides a framework in which investigators can keep an open mind in assessing the scientific evidence behind competing claims and interpretations of that scientific evidence, but it also permits that after this analysis is completed, 'informed judgements' about the validity of competing claims be made. As Millstone recently observed:

“....it may be methodologically appropriate to be impartial to the truth value of regulatory scientific judgements in advance of an exploration of the processes by which they were socially constructed, it is often unnecessary and inappropriate, and often intellectually perverse [to be impartial] once the judgements have been de-constructed. **(Millstone E 2004 p 37)**

In making such a bold assertion, Millstone and other Realist Constructivists openly recognise, and rely upon, many theoretical concepts of their predecessors (from several epistemological schools) in the study of the philosophy and sociology of science. Therefore, before returning directly to a further description and examination of the field of

Regulatory Science (and the case study of this dissertation) I now briefly consider, what I believe to be, some of the more important of those concepts, drawn from Karl Popper, Robert K Merton and Thomas Kuhn, which bear upon this dissertation.

2.2 Some Theoretical Concepts: Popper, Merton and Kuhn

The following insights and observations have been chosen because they appear to be particularly useful in examining and solving the central research questions of this dissertation – especially from the analytical perspective of Realist Constructivism.

2.2.1 Popper and ‘Falsification’

Karl Popper maintained that science advances most quickly and sure-footedly – not merely by repetitive confirmation of existing hypotheses, but also by concerted efforts to prove them false (to ‘falsify’ those hypotheses) in order that more accurate theories might arise and new hypotheses prevail over the old ones. **(Popper K 2002 pp 58-73)**

This concept of falsification is relevant to this thesis because in part the research examines to what extent, if any, a group of investigators led by Steven Blair attempted to ‘falsify’ the prevailing ‘vigorous threshold’ intensity hypothesis and to replace it with a new ‘moderate-volume’ of expenditure hypothesis, which they styled as a new moderate ‘physical activity-health paradigm’. **(Pate et al 1995 p 405)** If it turns out that Blair and the core group around him did falsify the vigorous physical activity threshold model, then that might suggest that the 1996 revision of the PA guidelines may have been a purely or predominantly scientific judgement. Whereas if this influential team of researchers instead ignored, undervalued, misinterpreted, and/or discounted evidence that apparently falsified such a proposed concave curvilinear ‘non-threshold’ model, and selected for consideration the evidence consistent with their own presuppositions, then it might be appropriate to conclude that scientific considerations on their own are not sufficient to explain the ‘paradigm shift’ in the PA guidelines and that, as pSSK might predict, social influences may also have played an important role in shaping these public health recommendations.

Popper’s focus was a normative methodological one, rather than a historical or sociological one, so it is perhaps not surprising that he did not address questions about

why and how investigators, in particular historical and social circumstances, might contrive to discount or ignore evidence which appeared to falsify their own favoured theories. In this study however, it will be useful also to ask whether the most influential group of investigators attempted to discount, disparage or even ignore evidence that challenged their own preferred hypothesis that moderate intensity activity can provide the same, or similar health benefits as more vigorous intensity activity and would, moreover, achieve substantially greater and longer sustained adherence in population, and public health terms.

2.2.2 Merton: The Four 'Norms' and His Attempted Definition of an 'Ethos of Science' by Contrast with the Desire for 'Fame'

The attempts by Blair and others in the moderate camp to 'falsify' the prevailing vigorous threshold hypothesis might also be usefully examined by seeing them in the context of the 'four norms' of scientific behaviour defined in the Inter-War years by Robert K Merton. Did the core group of scientists responsible for construction of the post-war physical activity guidelines strictly follow Merton's four tenets on how scientists, in any field, should conduct themselves to advance their science and its application in public health (the 'Ethos of Science'). Or were they, at least in part, guided by the desire to enhance their personal 'fame' and/or the reputations of their disciplines and institutions?

Robert K Merton's major works were written in the 1930s and 1940 when the growth of Nazism and Communism made him acutely aware that social and political forces might impinge on independent scientific inquiry: "Science must not suffer itself to become the handmaiden of theology, or economy or state. The function of this sentiment is to preserve the autonomy of science." **(Merton RK 1942a p 260)**

In defence and determination of what he described as 'the ethos of science' Merton described the four 'norms' that should shape scientific endeavour. They are briefly considered here in the order that he presented them in *The Normative Structure of Science* **(Merton RK 1942b)**.

Universalism:

Scientists shall reject making any claims influenced by their personal (and social) circumstances: “The acceptance or rejection of claims entering the lists of science is not to depend on the personal or social attributes of their protagonist, his race, nationality, religion, class and personal qualities are as such irrelevant. Objectivity precludes particularism”. **(op cit p 270)**

However, in a footnote to the 1973 reprint Merton observed that: “....the cultural context in any given nation or society may predispose scientists to focus on certain problems, to be sensitive to some and not other problems on the frontiers of science. This has been long observed” **(op cit p 271)**

It may be illuminating therefore to explore whether the differing ‘cultural context’ of Morris, from Britain, predisposed him in his investigations to focus on, and to be sensitive to, the benefits and bio-mechanics of vigorous intensity exercise – and whether in turn the same type of factor (but in this case a different ‘cultural context’) may have influenced Blair and other Americans to focus on, and be sensitive to the allegedly, previously unseen benefits of more moderate intensity activity.

This approach appears to echo Popper’s analysis of the differing processes of ‘discovery and justification’, because Merton then went on immediately to warn that this ‘cultural conditioning’ must not, however, be allowed ultimately to distort final ‘truth claims’: “....the criteria of validity of claims to scientific knowledge are not matters of national taste and culture. Sooner or later, competing claims to validity are settled by universalistic criteria.” **(op cit p 271)**

It may be also illuminating, therefore, to examine whether the decision to switch emphasis from vigorously intense to moderate activities in the 1996 US Surgeon General’s Report was based on ‘universalistic criteria’ alone or whether it was also influenced by non-scientific elements more to do with ‘national taste and culture’?

‘Communism/Communality’:

The ethos further required scientists to accept the ‘common ownership’ of ideas, although, importantly, Merton argued that under this norm the community of researchers allowed

individual contributors to bask in personal ‘glory’ when their own work was singularly praised:

“Property rights in science are whittled down to a bare minimum by the rationale of the scientific ethic. The scientist’s claim to ‘his’ intellectual ‘property’ is limited to that of recognition and esteem which, if the institution functions with a modicum of efficiency, is roughly commensurate with the significance of the increments brought to the common fund of knowledge.” **(op cit p 273)**

Merton did not, however, attempt to consider whether a desire for, and pursuit of, ‘recognition and esteem’ might influence the formulation of hypotheses or the interpretation of results, and if it did so, whether that might be epistemologically anomalous. It may be important in this dissertation to consider whether greater ‘recognition and esteem’ within the field of public health, and from the wider American public may have played any role in the selection of some framing assumptions, foreground theories, and subsequent interpretation of data in the physical activity guidelines debate.

Disinterestedness:

The key to the disinterestedness of scientists, argued Merton, lay not in their “unusual degree of moral integrity”, but “...a moral plausible explanation may be found in certain distinctive characteristics of science itself. Involving as it does the verification of results, scientific research is under the exacting scrutiny of fellow experts....The demand for disinterestedness has a firm basis in the public and testable character of science and this circumstance, it may be supposed, has contributed to the integrity of men of science.” **(op cit p 276).**

From his 1940s perspective Merton remained confident that such distortions of the science method would remain rare:

“Cultism, informal cliques, prolific but trivial publications – these and other techniques may be used for self-aggrandizement. But in general, spurious claims appear to be negligible and ineffective.” **(op cit p 276)**

However, in the last decades of the 20th century, and in the context of this dissertation, it may be important to consider whether that assertion by Merton can be applied to this

selected case study, especially in a field of public health policy making where, arguably, great social (economic, political and personal) pressures may have borne upon the decision making process. Investigators working in the 1980s and 1990s in fields such as physical activity and health may have become increasingly involved in a political and economic debate, given the scale of the human health problems now overwhelmingly acknowledged to have been occurring because of the chosen physical inactivity of 'labour saving' devices and sedentary lifestyles.

Organized Skepticism:

Of the four 'norms', perhaps 'organized skepticism' (sic) most clearly defined Merton's concept of the scientific ethos: "The scientific investigator does not preserve the cleavage between the sacred and the profane, between that which requires uncritical respect and that which can be objectively analysed." (**op cit pp 277-278**) It may be interesting to examine whether, and if so, to what extent, post-war investigators into physical activity and health felt the need to prove that they deserved full membership in this mindset of 'organized skepticism' to which Merton refers: shoulder-to-shoulder in fields densely occupied by individuals in long-standing disciplines recognised to be in the 'scientific community' such as physicists, chemists, mathematicians and, for the most part, physicians of medicine – but not, perhaps, investigators into human physical activity or even human diet and nutrition.

Further, Merton concluded: "Conflict becomes accentuated whenever science extends its research to new areas toward which there are institutionalised attitudes or whenever other institutions extend their control over science." (**op cit p 278**).

On the one hand, therefore, it may be interesting to explore whether physical activity investigators, purporting to be fully-fledged scientists, may well have irritated – indeed threatened – the traditional coaches and practitioners of sport and physical education. However, on the other hand and at the same time, the new post-war scientific study of physical activity may itself also have felt threatened and challenged by an established scientific and medical elite who exercised their own organised if selective scepticism against this fledgling discipline, which was insisting that it had a full role to play, not only in scientific and academic debate, but also in determining scientific guidelines for public health.

The Motive of 'Fame'

Merton was in part eager to explore what might be described as the 'scientific imperative' – the reasons or motives which drive people into scientific exploration, but he was also emphasising the norms and values that scientists supposedly acquired during their training, which channelled and regulated their explorative actions. In some contexts, there is evidence that scientists can be motivated by financial considerations to act as experts and consultants to commercial organisations, which hope to gain financially from the perceived authority of those experts. Merton saw that this 'imperative' could be interpreted more broadly, and arguably emerge, therefore, as more complex and fascinating, than the simple greed of fortune. In *Science and the Social Order*, he wrote:

“Just as the *motives* of scientists may range from a passionate desire in the furtherance of knowledge to a profound interest in achieving personal fame, and just as the *functions* of scientific research may vary from providing prestige-laden rationalizations of the existing order to enlarging our control of nature, so may other social effects be considered pernicious to society or result in the modification of the scientific ethos itself. There is a tendency for scientists to assume that the social effects of science *must* be beneficial in the long run.” (Merton RK 1942a p 263)

It may be important to consider whether some of the actions and judgements of Blair and his influential group may have included a concern for personal, academic and political fame that could be achieved by the introduction and adoption of a new vision of public health policy (the moderate 'physical activity-health paradigm'), which they believed would be beneficial to the American people.

2.2.3 Kuhn: 'Incommensurability'

As part of his exploration into the structure of scientific revolutions, Thomas Kuhn further questioned whether scientists in opposing camps or schools become so implacably constrained by their paradigms that they cease to be able to communicate with each other across paradigm boundaries – a condition that Kuhn termed 'incommensurability'. Popper

described Kuhn as an “historical relativist” who believed in “the domination of a ruling dogma over considerable periods.” **(Lakatos and Musgrave 1970 p 56)** By contrast, Popper appears to have believed in the idea of continuous debate and dialogue among those admittedly belonging to differing and competing schools of thought, which he described as ‘frameworks’. He assumed that all genuine scientists aspired to falsify their own hypotheses and those of others, without reference to the identity of the advocates of those competing claims. Those competing frameworks of scientists, routinely worked in the best interests of scientific discovery, remained able to communicate and, arguably, even to change their views and agree with their former opponents as new evidence in their debates emerged. Thus, Popper’s concept of a shared scientific ‘framework’ was inconsistent with Kuhn’s more adversarial vision of ‘incommensurability’ among competing paradigmatic communities. In this context, and against that background, it may be interesting to explore apparent attempts by Jeremy Morris, the leading British investigator and primary advocate of the vigorous intensity hypothesis, to search in the early 1990s for a consensus with the new ‘moderate intensity modernisers’ led by Steven Blair.

A final factor to consider is that Kuhn saw his revolutions as yielding victories to the far sighted and benefiting human understanding and the human condition itself. Yet Popper was not so certain that this could be achieved within Kuhn’s analytical framework. He observed that:

“‘Normal’ science, in Kuhn’s sense, exists. It is the activity of the non-revolutionary, or more precisely, the not-too-critical professional: of the science student who accepts the ruling dogma of the day; who does not wish to challenge it; and who accepts a new revolutionary theory only if almost everybody else is prepared to accept it – if it becomes fashionable, a kind of bandwagon effect. To resist a new fashion needs perhaps as much courage as was needed to bring it about.” **(Lakatos and Musgrave 1970 p 52).**

For Popper, fashionable ‘revolutions’ should be resisted if they were not supported by the available evidence. Within the context of this dissertation it may therefore be illuminating to explore whether investigators who continued to advocate public health guidelines based on vigorous activity were out of touch with the latest empirical evidence, or were, in Popper’s terms, ‘courageous’ in resisting a ‘fashionable bandwagon’ built upon powerful academic and other social influences, but on slender and selective bodies of evidence?

2.3 Regulatory Science

A further working assumption shall be that the subject and scope of this dissertation – the post World War II construction of US public health guidelines for physical activity – lies broadly within the contentious area at the intersection between science and policy-making, which was first characterised by Weinberg in 1972 as ‘Trans Science’. **(Weinberg A 1972)** Subsequently, the idea was clarified and elaborated, most notably by Mazur **(Mazur A 1973)** and Ravetz and Funtowicz **(Funtowicz and Ravetz 1990)** in terms of ‘Regulatory Science’. Second, the nature and scope of this dissertation will be categorised and examined within the context of similar studies of public health policy-related regulatory science that have preceded it and that will be referenced later in this chapter (Garrety, Smith and Nicolson, Nestle, Gillespie and colleagues, and Millstone and van Zwanenberg). These ‘categories’, defined and developed here, are intended to help to illuminate and to explain the range of ways, and means by which, scientific evidence may have been socially, and thus unscientifically, interpreted, ignored or omitted.

According to Jasanoff, a leading American Realist Constructivist, since the 18th century Enlightenment, the unalloyed benefits of science to human development, and the admirable independence (‘disinterestedness’) of scientists in pursuit of knowledge and discovery were, until recently, rarely challenged. Jasanoff maintained that this ‘age of innocence’ did not end in the United States, and scientists did not struggle to maintain their ‘cognitive authority’, until the pesticide controversies of the early 1970s **(Jasanoff S 1987 p 200)**. According to Millstone, a leading British Realist Constructivist, a similar test of science’s ‘cognitive authority’ first began to emerge in the United Kingdom over concerns about the risks of nuclear plants following the fire and radiation discharge at Windscale (now Sellafield) in October 1957 **(personal communication with EP Millstone 2008 and also see Wynne B 1982 and 1982a)**. In the United States the pesticides controversy was first elucidated in the early 1960s with the publication of *Silent Spring* by Rachel Carson, herself a scientist (marine zoologist). **(Carson R 1962)** Carson’s depiction of the urgent but still ungrasped need to regulate use of agrochemicals to protect human health and the wider environment was powerful and prescient: As Carson explained:

“There is still very limited awareness of the nature of the threat. This is an era of specialists, each of whom sees his own problem and is unaware of or intolerant of the larger frame into which it fits. It is also an era dominated by industry, in which the right to make a dollar at whatever cost is seldom challenged. When the public protests, confronted with some obvious evidence of damaging results of pesticide applications, it is fed little tranquillizing pills of half truth. We urgently need an end to these false assurances, to the sugar coating of unpalatable facts. It is the public that is being asked to assume the risks that the insect controllers calculate. The public must decide whether it wishes to continue on the present road, and it can do so only when it is in full possession of the facts.” **(Carson R 1962 pp 30-31)**

Carson referred optimistically to the American public being in ‘full possession of the facts’ –but one might ask: which facts, and explained and interpreted by whom? Prior to this first ‘pesticide controversy’, Jasanoff argued, science and its practitioners were broadly trusted to provide those ‘facts’:

“Much of the authority of science in the twentieth century rests as well on its success in persuading decision-makers and the public that the Mertonian norms present an accurate picture of the way science really works. Unlike politics, science is ‘disinterested’ and ‘objective’, and unlike religion is ‘sceptical’.” **(Jasanoff S 1987 p 196)**

In 1972, the same year that the first agricultural uses of the pesticide DDT were banned after much conflict and controversy in the United States, Weinberg first attempted to define the boundaries of this emerging arena of regulation and science policy making– which he described as ‘trans-science’:

“Many of the issues which arise in the course of the interaction between science or technology and society – e.g., the deleterious side effects of technology, or the attempts to deal with social problems through the procedures of science – hang on the answers to questions which can be asked of science and yet *which cannot be answered by science*.” **(Weinberg AM 1972 p 209)**

Weinberg's aim was not to admit to the weakness/short-comings of science or scientists, but rather to defend them by defining the 'true science' boundary wherein their authority and trust could not, and should not be assailed, as Jasanoff made clear:

"The authority of science is seriously jeopardized when scientists are called upon to participate in policy-making. Administrative decision-making often requires a probing of the areas of great indeterminacy in science. Regulation of risks to health and the environment, in particular, involves issues at the frontiers of current scientific knowledge, where consensus among scientists is most fragile.....Adherence to the Mertonian norms, coupled with a long tradition of critical peer control, has given scientists an assured basis for claiming cognitive authority. The policy process, however, simultaneously casts doubt on the disinterestedness and the certainty of science." **(Jasanoff S 1987 pp 197- 98)**

In a later (1985) paper, Weinberg was, perhaps predictably, scathing of this less rigorous and less reliable 'new branch' of 'regulatory science' – this bastard child of his own description:

"One way to deal with these assaults on scientists and scientific truth would be to define a new branch of science, called regulatory science in which the norms of scientific proof are less demanding than are the norms in ordinary science." **(Weinberg AM 1985 p 68)**

Funtowicz and Ravetz, however, subsequently viewed Regulatory Science quite differently. While accepting that the science relied upon in regulatory areas was often more uncertain than conventional or 'academic science' they nevertheless described regulatory science as a bold, even brave discipline operating in the most difficult circumstances, where, they argued: "Decisions frequently need to be taken even though facts are uncertain, values are in dispute, levels of trust are low, stakes are high and decisions are urgent." **(Funtowicz and Ravetz 1993)**. Below, I examine how apt is this definition and description when applied to the context of public health regulation – and specifically to the preparation and publication of the *1996 US Surgeon General's Report on Physical Activity and Health*.

2.3.1 Public Health Physical Activity Guidelines: Within the Orbit of Regulatory Science

Commonly, regulatory science has been characterised by, and examined in commercially-based cases (**Nelkin D 1975, and Nestle M 1993**), which often have been controversies where the makers or owners of a product or process (for example a pesticide, a nuclear power plant or an airport runway) have sought government (regulatory) approval for its production, in the face of opposition from some citizens or public interest groups who contended that the product or process was a threat to public health and/or to the environment. There was, at the core of each debate, a ‘macro-economic’ argument which each side tried to influence with scientific evidence specifically chosen to support their particular social positions.

Clearly, public health guidelines, in general, can involve ‘macro-economic’ arguments. Official advice on smoking cessation, and dietary choices are but two obvious examples where the tobacco and food industries have much to win or lose financially by influencing public health pronouncements. However, in the field of physical activity any such ‘macro-economic’ influence is *prima facie* less evident and may, therefore, be of less, or even, of no real importance. It is not immediately obvious that commercial forces were used directly to influence the physical activity guidelines’ construction during the time frame examined by this dissertation (1948 – 1996). Nevertheless, the construction of the physical activity guidelines may be accommodated within a regulatory science framework, as described by Weinberg, and Funtowicz and Ravetz, for the following reasons:

As will be examined and explained later in the empirical sections, the United States and other Western governments in the post World War II period needed with increasing urgency to begin to devise strategies to improve and increase leisure time physical activity among their populations. This need arose directly from: rapid mechanisation and consequent reduction in manual occupational labour both at home and in external workplaces; affordable motor cars; cheap, sedentary home entertainment, and the growing availability of inexpensive, energy dense foods and beverages. All of these changes brought gradual, but growing awareness of the ‘deleterious side effects’ of unhealthy physical (inactivity) – such as increases in cardiovascular disease, unhealthy weight gain and incidence of colon cancer – and these health consequences were being driven, at least in part by these technologies. Weinberg’s concern about the need to deal with “the deleterious side effects of technology or the attempts to deal with social problems through

the procedures of science” (**Weinberg AM 1972 p 209**) is most relevant - since devising public health physical activity guidelines, portrayed as using the best available medical and social science, was, and remains, a clear attempt “to deal with social problems” of an increasingly sedentary society caused primarily by those technologies. (**op cit 1972 p 209**)

To a large extent, construction of the guidelines also fits well with the description of Regulatory Science given by Funtowicz and Ravetz. Evidence will be examined to determine whether the decision taken by the US Government to switch emphasis from vigorous to moderate intensity physical activity recommendations was taken even though the evidence base (facts) for that decision was very uncertain, the public health stakes were high, and the decision (not least because the 1996 Atlanta Olympic Games were looming) was deemed to be very urgent. Aspects of their description that fit less well are “disputed values and low levels of trust”. (**Funtowicz and Ravetz 1993**) Nevertheless, the evidence will be examined, using the political Sociology of Scientific Knowledge (pSSK) approach, to determine whether the intense advocacy of those investigators and policy makers, whom I shall call the ‘moderate modernisers’, led them selectively to interpret, omit and include data to bolster their working hypothesis. It may also be illuminating to discover whether any such actions led to a dispute about scientific values and reduced trust between them (the modernisers) and the scientific staff at the Centers for Disease Control and Prevention who were brought in to attempt to ensure that the Surgeon General’s Report would receive inter-agency clearance and thus could be published before the opening ceremony of the Olympic Games commenced.

It may well be important, therefore to examine closely not only the knowledge claims, but also the judgements of the scientific experts who were brought into the US Surgeon General’s taskforce. These judgements are likely to have included specific interpretations of data from the scientific literature about the specific benefits of particular types of physical activity. Use of techniques from the pSSK operate upon the assumption that both such claims and judgements, while claiming to be purely scientific, may have actually been constructed with implicit social considerations that need to be, and can be disentangled and made explicit.

2.4 Some Potentially Relevant Case Studies which Addressed Similar Questions and Issues: a theoretical framework

Earlier authors in other regulatory case studies on science based policy-making have highlighted and examined a number of contentious issues and key elements which may be relevant to important aspects of the study of the scientific and social construction of post World War II public health guidelines for physical activity in the United States. Here, using the pSSK approach, I have chosen to combine concepts from these authors and to group these social issues and elements taken from the studies into 3 categories (and further sub-categories) to which I have given my own descriptive titles in hopes of providing some coherence and cogency as follows: External Anomalous Influence, (Mis)use of the Authority of Science, and Implicit Cultural Conditioning. It is hoped that this classification may help to illuminate and explain how and why scientific evidence may be distorted by social (unscientific) influences in the context of this dissertation and, hopefully, in subsequent examinations by other investigators.

2.4.1 External Anomalous Influence

Several previous studies, outlined below, have described how seemingly 'independent experts' offering scientific advice were recruited to influence regulatory debates and decision making toward a desired goal or outcome. This 'involvement' may occur: at the (explicit or implicit) behest of the regulatory policy maker, at the primary instigation of the external 'expert,' or stem from both, or even from other stakeholders. The 'involvement', by whatever route, becomes disproportionate – and hence anomalous -- when the effect of the intervention is to conceal, disallow or at least to mis-interpret science based evidence with the implicit or explicit consequence to promote, permit or at least facilitate a chosen non-scientific (social) outcome. Three relevant examples of such 'external anomalous influence' are examined below as follows: 1. Disproportionate reliance on external advisors/experts 2. 'Enrol and translate' – the external infiltration to gain power within an

influential organisation 3. Direct external ('lobbying') pressure to influence regulatory decision making.

2.4.1.1 Disproportionate Reliance on External Advisors/Experts

External scientific experts may be invited in to the decision making process by the regulatory authority itself. For example, in their trans-Atlantic (UK/US) study of the regulatory examination of the pesticides Aldrin and Dieldrin, Gillespie and colleagues demonstrated that the agencies under examination, the US Environmental Protection Agency (EPA) and the UK Ministry of Agriculture (MAFF), both chose to rely heavily on the advice of external experts who had strong and conflicting views about how the carcinogenicity of pesticides should be evaluated. **(Gillespie et al 1982)** The UK MAFF, which had strong and explicit links with the farming lobby, chose external experts (toxicologists) whose intra-disciplinary culture and methodology led them to take a relatively benign view about the risks of pesticide exposure to human health. Whereas the US EPA, with no such ties to farming – and, indeed, with an explicit remit to protect the public and the environment -- chose as their lead external expert, Umberto Saffiotti, head of the US National Cancer Institute. Gillespie and colleagues summarised as follows:

“Moreover, the social and scientific commitments embedded in the advice were consistent with the two decisions: the more agriculturally-oriented advice with the British decisions, and the more health protective advice with the US decision.” **(op cit p 315)**

It was predictable, the authors concluded, that the British authorities, evaluating the same evidence, should deem the pesticides acceptable for use, while the US authorities successfully argued in court that they were carcinogenic and should be banned. It may, therefore, be illuminating to consider whether the US Surgeon General's assembled taskforce on physical activity and health so comprehensively switched policy emphasis from vigorous to moderately intense activities because of their disproportionate reliance for scientific interpretation upon the advice of a small group of external experts, and/or whether the decision can be accounted for in terms of the disproportionate emphasis on some studies and some evidence, and the relative down-grading or complete neglect of others.

2.4.1.2 To 'Enrol and Translate'

The involvement of external scientific experts may not always be initiated at the request or invitation of a welcoming agency. Scientists without a sufficient powerbase, may also seek to gain entrance to powerful bodies to enhance their own reputations, and in turn, the credibility of their hypotheses – a process which Karin Garrety has described as to 'enrol and translate' themselves and their scientific claims into positions of power and influence. (Garrety K 1997)

In her insightful examination of the 'cholesterol controversy' in the 1960s and 1970s, Garrety examined how nutritionist, Ancel Keys, the leading proponent of the dietary cholesterol hypothesis (as a primary risk factor in heart disease) turned the theory, without undisputed evidence, into a claim that was widely treated as if it were an established medical fact of 'warranted authority'. **(op cit 1997)** Keys did so, she argued, by using a charismatic mixture of charm, determination and force of argument to gain positions of influence (to 'enrol and translate') within the American Heart Association (AHA) – causing it to move rapidly from a stance of scepticism and even mistrust of a 'dubious nutrition theory' to rapid embrace and endorsement of the claim that consumption of dietary cholesterol/saturated fat was a significant risk factor in cardiovascular disease.

Garrety's use of what might be described a realist approach to Actor-Network Theory – an epistemological position often employed by Latour and other social relativists - will be examined later in this chapter and in the chapter on research methodology, as it may prove a useful theoretical and methodological tool for this dissertation. Her account of Key's role within the AHA will be explored in some depth later (see Chapter 10) because it may illuminate Steven Blair's apparently similar efforts to enlist ('enrol and translate') the AHA in endorsing his moderate 'physical activity-health paradigm' at a time when he was working to make it an established tenant of US public health policy.

2.4.1.3 Direct Pressure to Alter Public Health Guidelines

Commercial organisations, which stand financially to lose or gain from public health policies and guidelines, have long attempted to exert pressure on governments and their agencies by employing lobbyists to promote outcomes beneficial to their sales and profit margins, but arguably to the detriment of the public's health.

Just such a conflict between commercial gain in public health policy making was closely examined by Marion Nestle in her study in the 1990s of attempts by organisations within the US food industry to influence the content and wording of the US Federal Government's nutrition guidelines. **(Nestle M 1993)** Key to the regulatory dilemma was, and remains, the twin mandates of the US Department of Agriculture (USDA) to boost US farm production (and the profits of American farmers) while protecting the public's nutritional health. Nestle explains that this dual role was not seen as dichotomous when the USDA was established in 1862 – long before the many 'farm-to-fork' debates began about public health issues (such as saturated fat intake, energy dense 'junk foods', and unhealthy weight gain and obesity) which have put the farm/food manufacturing lobbies and public health officials and campaigners at loggerheads. As Nestle observed:

“As dietary recommendations shifted from 'eat more' to 'eat less', the USDA's dual mandates to protect agricultural producers and to advise the public about diet created increasing levels of conflict....food producer lobbies became much more actively involved in attempts to discredit, weaken, or eliminate dietary recommendations that suggested using less of their products.” **(op cit pp 485-6)**

The analogous case for a possible conflict between commercial gain and the public health in the parallel construction of US government physical activity guidelines during the same period is therefore worth examining, but it may not be straightforward. For example, it might be argued that the outcome (the headline recommendation being switched from vigorous to moderate intensity activity) would have been opposed by sports equipment manufacturers and gym owners who stood to lose revenue if the American public took up, en masse, the primary recommendation of 'brisk walking' – a pursuit requiring no membership fees and only a comfortable pair of shoes.

However, while it may be tempting to seek further parallels between the concurrent construction of US nutrition and physical activity policy, an alternative account might be developed in terms of a conflict and competition over 'pride or fame' in the Mertonian sense between scientific investigators in the field of physical activity and health.

2.4.2 The Authority of Science: Its (Mis)use and Impact

Several recent and relevant case studies have demonstrated how the supposedly independent authority of science – as described by the Mertonian Norms – has been used not only to observe, measure and interpret the natural world, but also misused to bolster and to give (spurious) authority and authenticity to social claims and policy goals. Relevant examples of the ‘misuse of the authority of science’ are examined below as follows: 1. To bolster policy decisions 2. Conflicting schools or disciplines of scientific thought 3. Reciprocal impact of social factors upon scientists and scientific evaluations

2.4.2.1 To Bolster Policy Decisions

In their exploration of the early 20th century ‘vitamin debate’ Smith and Nicolson demonstrated how the Glasgow School of chemical physiologists, led by Paton, Findlay and Cathcart, did not merely use their scientific authority in an attempt to discredit the vitamin theory of their emerging academic adversaries, the Cambridge biochemists, that such ‘micro-nutrients’ were essential to prevent diseases such as rickets. **(Smith and Nicolson 1989)** Rather the ‘conservative style’ of thinking and discourse of the Glasgow School went further and extended into a defence of conservative social policy generally in areas far removed from scientific debate. As defenders of class, property and privilege, the Glasgow School therefore wished also to discredit the public health role of vitamins as essential nutrients, which were absent or deficient in the cheap food stuffs that the poor were forced to eat. Feckless parenting, rather than the vitamin deficiency of poverty was, in their view, the cause of rickets: As Smith and Nicholson explained:

“They [The Glasgow School] also used the conservative style in the social sphere, in arguing for health policies which served the economic and political interests of the established order as against those of the working class....one principal bone of contention between Cambridge and Glasgow was the aetiology of rickets.” **(op cit p 198)**

In a different, but similarly intricate examination, Millstone and van Zwanenberg showed in their study of the UK bovine spongiform encephalopathy BSE crisis how the authority of a carefully chosen expert scientific committee (the Southwood Working Party) could be used in apparently contrary ways: to spare, with expert authority, the Treasury from ‘unnecessary’ and costly expenditure to protect the food chain; to protect the reputation of Ministers who did not want to remove even overtly diseased animals from sale; yet simultaneously, and with the same scientific authority, to reassure the British (and

European) public that British beef was safe to eat. **(Millstone and van Zwanenberg 2001)**

The authors further maintained that MAFF was itself split between the Secretary of State, John MacGregor, who, in order to please the Prime Minister's, (Margaret Thatcher) demand for public expenditure cuts, opposed removing overtly diseased cattle from the food chain unless the meat industry met the costs -- and his senior officials at the ministry who disagreed with him and favoured the removal of the diseased animals from the food chain on public health grounds, and at public expense. The officials went to the Chief Medical Officer (CMO) at the Department of Health to seek his support, but he was too timid to cross the Prime Minister. The CMO decided instead, therefore, to establish the Southwood working party to provide what van Zwanenberg & Millstone called 'eminential' rather than 'evidential' support.

Those policy decisions, constructed from deeply political, economic and social reasons were nevertheless disguised by MAFF as being purely scientific (objective, disinterested, and sceptical) because they appeared to emerge from, or receive the approval of, an expert panel depicted by the Government as entirely authoritative, when not one panel member had any specialist expertise in animal or human neuropathologies. As Millstone and van Zwanenberg argued:

"To summarise, the Southwood Working Party's conclusions about extending the feed ban were subordinated to the prior policy judgements of MAFF officials. Officials then represented the Committee's conclusions as purely scientific in nature, drawing on the spurious scientific veneer of authority provided by the Working Party to defend officials policy decisions in the face of criticism from the public, the animal feeding industry and even their own ministers; a tactic that the members of the Working Party did not overtly challenge."

"...Those arrangements suited officials and ministers because it allowed them to argue that they were doing what, and only what, their scientific advisors recommended, and it allowed officials to use the ostensible scientific authority of the Committee to persuade the public, the Treasury, other government departments, ministers and the beef industry to accept their policy preferences.

It also flattered the scientists by representing them as authoritative and influential.” **(op cit pp 106-9)**

In this context, evidence will be examined to see whether the 1996 Report of the US Surgeon General on physical activity also relied on the ‘spurious scientific veneer’ of expert scientific panels which claimed not only an “emerging consensus” **(USSG p 3)** about the surprising benefits of moderate intensity activity, but even went so far as to proclaim their findings represented a new moderate “physical activity-health paradigm.” **(Pate et al 1995 p 405)**

2.4.2.2 Conflicting Schools or Disciplines of Scientific Thought

Another frequent theme in the literature on regulatory (and public health) science policy is the role of conflicting schools or disciplines of scientific thought to defend or to bolster conflicting social policy decisions. Smith and Nicolson argued that vested interests, including physicians and others in the propertied classes, may have invoked the authority of the chemical pathologists of the old Glasgow School in hopes of seeing off the challenge that the biochemists presented, not only to their status, but also to their wealth, when the biochemists asserted that only expensive food stuffs containing contentious vitamin micronutrients could cure the poor of rickets and other diseases of malnourishment. **(Smith and Nicolson 1989 p 196)**

Similarly, Gillespie and colleagues argued that the oil and agrochemicals corporation Shell and the UK Ministry of Agriculture chose the authority of toxicologists whose scientific judgement was that the carcinogenic risk of pesticides could be estimated by an incremental dose-response calculated above a ‘no observable effect level’ (NOEL). Whereas the US Environmental Protection Agency, with a remit only to protect the environment and public health, relied upon the authority of molecular biologists and biochemists who were of the scientific opinion that no dose of a genotoxic substance was too small to ‘trigger’ a carcinogenic response. **(Gillespie et al 1982 p 314-15)**

In this context of ‘triggers’ and ‘effect levels’, it may be illuminating to explore the two main and conflicting theories in the physical activity and health debate. For example, was Morris’ concept of a minimum threshold of intensity **(Morris et al 1973 p 333)** similar to the ‘trigger’ effect of the microbiologists – albeit in inverse ways: namely, that a minimum intensity ‘threshold’ of energy expenditure was necessary to ‘trigger’ a healthy, protective

response. Or, more accurately and in line with the toxicologists, did his hypothesis suggest that there was a minimum, protective intensity of activity, below which no (desirable) effect level of heart protection could be seen? By contrast, the ‘total volume’ hypothesis of energy expenditure, at any intensity, of Blair and colleagues appears, in certain versions, to require no minimum ‘trigger’ of activity below which no (desirable) effect can be seen, but nevertheless accepts a certain degree of incremental dose-response in health outcomes with increasing volume, but not intensity, of energy expenditure.

While Morris was himself a physician (MD) his minimum threshold concept fitted comfortably within the accepted thinking of exercise physiologists and sports trainers of the period. As we shall see, however, this ‘vigorous intensity hypothesis’ was challenged from the mid-1980s by Steven Blair and other investigators who believed that the total volume of activity – conducted at any intensity – was the incremental dose-response mechanism behind cardiovascular and all cause mortality risk reduction. A minimum threshold of intensity (and/or fitness) was deemed initially by Blair and subsequently by others not to be necessary, and therefore a recommendation for ‘more comfortable’ activities of moderate intensity activity was put forward. They further argued that vigorous activity deterred many people, while more moderate activities would achieve greater population-wide adherence, and this ‘scientific’ recommendation may have facilitated the adoption of the revised policy guidelines. In any event, the two hypotheses represented two very different and conflicting schools of scientific thought on whether ‘intensity’ or ‘total volume’ of energy expenditure was the key to disease prevention and health promotion.

2.4.2.3 Reciprocal Impact of Social Factors upon Scientists and Scientific Evaluations

While the ‘authority of science’ has been seen substantially to influence regulatory debate and policy making – it may also, and reciprocally (or ‘reflexively’) be true that sudden exposure to the public spotlight, especially to those unused to the glare, may affect the selection and interpretation of evidence by scientists themselves.

For example, Gillespie and colleagues also explored what may happen to the attitudes, thinking and decisions of scientists newly caught up in the more public and contentious world of regulatory science policy making. They quoted a paper by E Pfizer (‘Toxicology’) which had summarised the conflicting reactions of a typical toxicologist thus:

“....at once both frustrating and stimulating; frustrating because he doesn't have the answers to many of the perplexing questions being asked; frustrating to some toxicologists because their time-honoured methods for making judgements about safety evaluations are being challenged; stimulating because suddenly there are a multitude of people interested in his professional activities...He can expect his data to be scrutinized by non-scientists, to be interpreted in the newspapers and in legal hearings, to face requirements for exactness and statistical validity with increasing rigour. This life of the toxicologist will never be the same.” **(Gillespie et al 1982 p 329)**

This suggests that, by analogy, it may be appropriate to ask if a relatively small group of exercise physiologists, who had previously led a relatively obscure existence in college exercise laboratories and on athletics grounds, were suddenly catapulted into (or were able to capture) the high profile world of public health?

2.4.3 Implicit (and/or Explicit) Cultural Conditioning

Regulatory agencies and other governmental authorities seldom, if ever, operate without an implicit (and sometimes explicit) set of framing assumptions and allegiances that may influence their selections and interpretations of evidence and impact upon their policy decisions. These may arise from several factors – not least their remit at their inception, accrued traditions, dominant individuals within the agency, and explicit or implicit alliances with individuals or bodies outside of it. Relevant examples of ‘implicit’ (and/or ‘explicit’) cultural conditioning are examined below as follows: 1. Deep cultural allegiances/alliances 2. Exclusion of ‘outsiders’ and sources of dissent 3. Selective omission, inclusion and interpretation of scientific evidence.

2.4.3.1 Deep Cultural Allegiance/Alliance

The history and culture of a regulatory agency can be so entwined with the industries that it regulates that awareness of the ‘incestuous’ relationship ceases to be evident. This anomalous embrace was clearly demonstrated by van Zwanenberg and Millstone in their examination of the regulatory scrutiny of the EBDC (ethelyene bisdithiocarbamates) group of fungicides. **(van Zwanenberg and Millstone 2000)** They asked why the UK Ministry of Agriculture (MAFF) decided that the EBDC group of fungicides posed no significant risk to

human health when, and upon the same available evidence, the US Environmental Protection Agency (EPA) concluded that the fungicides were a 'probable human carcinogen'.

In what they described as "in descending order of attractiveness", the authors suggested that the Ministry's Advisory Committee on Pesticides (ACP) must have done one of the following:

1. Selected evidence in a "shoddy and unsystematic fashion"
2. Accepted 3rd party "shoddy and/or biased evaluation" without due scrutiny
3. Selected in a "systematically biased fashion" to achieve its desired conclusion

The authors concluded that: "Not only is discretion enormous and accountability and transparency severely limited [within the ACP], but potential conflicts of interest between regulators and industry are procedurally unacknowledged." **(op cit p 274)**

While most studies have examined how such anomalous relationships can favour industrial clients such as agrochemical companies, this 'bias' can, as Gillespie and colleagues observed, occasionally appear to benefit environmental protection and/or public health: "The vigorous manner in which the EPA has subsequently endeavoured to protect the US environment has led critics to accuse the agency of 'capture' by environmentalists." **(Gillespie et al 1982 p 317)**

Similarly, it may be appropriate to ask whether the decision in 1983 by the US Centers for Disease Control and Prevention (CDC) to set up a unit specifically to explore the benefits to public health of physical activity led directly to its 'capture' by a group that appeared to offer a moderate 'physical activity-health paradigm' that would please politicians, policy makers and the American public – while enhancing the reputation of the CDC?

2.4.3.2 Exclusion of 'Outsiders' and Sources of Dissent

Kuhn's concept of 'incommensurability' suggests that proponents of a successful hypothesis may consciously choose not (or gradually and unconsciously become unable) to engage with those holding opposing views who interpret the evidence differently. The latter individuals rapidly become 'outsiders' and their voices of dissent are ignored, stifled, or in some cases, entirely silenced. **(For more on Kuhn's concept of**

incommensurability see, for example: Lakatos and Musgrave 1970 p 56 and Kuhn TS 1973 pp 93-103)

In this context, one of the most intriguing aspects of the historical narrative examined in this dissertation is the speed with which the ‘moderate modernisers’ appear to have succeeded in gaining overwhelming dominance in the key panels and committees that framed the physical activity public health debate over government guidelines. ‘Vigorous dissenters’, with the primary exception of Jeremy Morris, were either not heard, or were outsiders whose voices were marginalised.

Gillespie and colleagues described a similar phenomenon in assessing why Aldrin and Dieldrin were given such robust and easy approval in Britain. They argued that:

“Since there was virtually no way for ‘outsiders’ to contribute to the British decision, there was no way that EPA’s witnesses’ case could be presented systematically. But even if there were, it is not clear whether any British scientific equivalents to Saffiotti and his colleagues [EPA outside expert witnesses] existed, or whether they would contribute to the decision-making process if they did.” **(Gillespie et al 1982 p 320)**

It might therefore be useful to ask if analogous processes occurred in the preparation and construction of the *US Surgeon General’s 1996 Report on Physical Activity and Health*?

2.4.3.3 Selective Omission, Inclusion and Interpretation of Scientific Evidence

The Schools of ‘Scientism’ (the Positivists and Falliballists) insist that scientists either infallibly do not, or certainly should resist any temptation to, ignore or discard evidence that fails to fit or disturbs their hypothesis – or similarly selectively to include only that evidence that flatters and bolsters their position. Equally, as Merton argued, scientists must be scrupulously ‘disinterested’ in their fair and balanced interpretation of all the evidence available.

Yet do these restraints always (indeed seldom, if ever) work, especially in areas of Regulatory Science? For example, in their examination of why the US Environmental Protection Agency found the pesticides EBDCs to be potential genotoxic carcinogens, while the UK Ministry of Agriculture did not, Millstone and van Zwanenberg looked closely

at the Ministry's choice of which studies to include in its analysis and which to exclude. They concluded the pattern was conspicuous:

“In particular, it [the UK assessment] included certain genotoxicity evidence (that was generally supportive of its reassuring narrative on safety) even though that evidence did not meet its own selection criteria. At the same time, other genotoxicity evidence that elsewhere fulfilled the ACP's supposed criteria of selection (but undermined the ACP's chosen narrative) was excluded.” **(van Zwaneberg and Millstone 2000 p 271)**

Similarly, it may be illuminating in this dissertation to question whether the US Surgeon General's Report selectively included and gave greater emphasis to the rare and unusual studies which favoured the greater health benefits of moderate activity, and underplayed or even excluded some studies which favoured more vigorous intensity activities?

It would appear that such selective exclusion, omission or interpretation of scientific evidence may be a result of implicit (or explicit) cultural conditioning, but also of many other social influences, some of which have been categorised above. In the narrative and chronological chapters that follow any such apparent anomalies of interpretation in the scientific, polemic and policy literature will be explored in depth. They will be further examined in the chapter devoted to the Surgeon General's Report itself (Chapter 9) and then subjected to further analysis and synthesis in the concluding Chapter 10.

2.5 Chapter Summary and Conclusions

In her book *The Fifth Branch: Science Advisers as Policy Makers*, Jasanoff observed: “It has been amply documented that technically trained adversaries can exploit uncertainties in the scientific knowledge base to construct evaluations consistent with their political objectives.” **(Jasanoff S 1990 p 81)**

Modern scientific study of the impact of physical activity on health outcomes was in 1996, and remains, a relatively young field. It will therefore be particularly important to examine any uncertainties of its knowledge base and to question whether the ‘emerging consensus’

for moderate intensity activity, as hailed in the opening page of the US Surgeon General's 1996 Report, was a valid or anomalous claim.

In the light of that review of theoretical approaches and analytical tools, the central research question of this dissertation can be refined in the following terms:

1. Were the public health physical activity guidelines produced in the 1996 US Surgeon General's Report on Physical Activity and Health, which became the template for the Western world, based solely on the best available scientific evidence?
2. Or were they a 'hybrid' constructed not only from scientific evidence, but also from non-scientific (social) elements which can be 'disentangled', examined, interpreted and explained?

Having examined several theoretical frameworks with which to explore that question, it now appears that an approach based primarily on Realist Constructivism provides the most appropriate epistemological account. A preliminary examination of the literature shows that the study of physical activity and health has had a growing scientific base which requires a realist (as opposed to a relative) approach to examine these knowledge claims.

Preliminary examination further suggests, however, that there are considerable gaps in the knowledge base of the literature – leaving scope for anomalous interpretations of the evidence for possibly social (non-scientific) reasons. The political Sociology of Scientific Knowledge (pSSK) – a key tool used by Realist Constructivists to examine and analyse such apparent uncertainties, ambiguities and anomalies of interpretation and to discover their (possible) social causes - would seem to be the most promising method of discovery and analysis in the field and time period under review in this dissertation.

However, pSSK has primarily been used in studies where the primary 'social' factor was 'external' to the relevant scientists and their literature. It has also been 'macro-economic' in foundation – most notably in circumstances, such as those analysed by Jasanoff, Millstone, Nelkin, Nestle and others, where commercial interests were at work attempting to influence interpretation of the science base for their own financial benefit. Preliminary

examination in this dissertation suggests a different picture where many impinging 'social' factors may have been 'internal' to the relevant scientists and may not have been primarily driven by external 'macro-economic' influences.

As has been mentioned briefly earlier in this chapter, Garrety's 'realist' approach (perhaps an intermediary between Realist Constructivism and Social Relativism) which she employed in her study of Ancel Keys and the 'cholesterol debate', may also be illuminating here as a theoretical technique to examine whether a small group of like-minded physical activity investigators played an important 'internal' role in shaping public health policy decisions for reasons other than macro-economic financial gain. Garrety accepted that a genuine, but incomplete science base (the study of dietary saturated fat and cholesterol) might be influenced and interpreted by scientists such as Keys and his collaborators who used charm, determination, and force of argument to gain positions of influence among public health policy makers. **(Garrety K 1997)**

A combination of Realist Constructivist pSSK with Garrety's 'realist' social stance, while a somewhat unorthodox amalgam, may therefore be the most promising theoretical approach for the material considered in this dissertation. In the simplest terms, the approach might even be regarded as a realist version of Actor-Network Theory, where the under-pining science is real, definable and important (realist) – but so too are the 'actors', the prominent scientists who may have been able to use their powers of persuasion (anomalously) to influence public health (science policy) decisions. This combined approach – primarily to employ Realist Constructivist pSSK, but also to use Actor-Network Theory in its realist version after Garrety – is further explained in the following chapter.

A research methodology is set out in the next chapter to examine what sources of information to answer the research questions are available and how they might best be utilised.

Chapter 3 Research Methodology

3 Introduction

This chapter considers the research methods and principal data sources that will also serve to underpin and shape the investigations of this dissertation.

The central research question, re-stated towards the end of the previous chapter, may also be separated for greater clarity as three inter-related sets of questions. They are:

1. Why were the US public health guidelines for physical activity changed in 1996, and in particular why was emphasis switched from vigorous intensity to moderate intensity activities? Was the decision based on sound and uncontested scientific grounds, and on those alone?
2. Did any external, social (and non-scientific) factors influence that change, if so can they be identified?
3. Did any internal social factors (among the scientific investigators and/or the policy makers) influence the change those guidelines, and if so can they be identified?

3.1 Research Methods Employed

3.1.1 Personal background

Most of my working life has been spent in journalism, primarily with the Guardian newspaper and with BBC radio and television. Much of that work has focused on public health subjects including: the misuse of pesticides and livestock drugs (also published as a book by Penguin in 1986); bovine spongiform encephalopathy (BSE 'mad cow disease'); and several investigations into the chemical and pharmaceutical industries, not least into their attempts to control, or at least heavily influence, their own regulation by government policy makers.

This background, I suspect, very much inclined me to the realist constructivist epistemological perspective, in as much as I have specialised in investigating many 'case studies' in which the science underpinning them has been disputed, influenced

and interpreted, most commonly by macro-economic forces such as industries (versus campaigning organisations) within settings governed by Regulatory Science.

My academic background, however, is not in science, but the in liberal arts. I earned a BA (summa cum laude) at Brown University in American history and politics, and subsequently a 1 year post-graduate degree by dissertation at Cambridge University in early 19th century English economic history.

It is also important to know that the gestation of this dissertation began when I left full-time journalism in 1999 to take up the job of 'senior scientific policy officer' in London at the *International Obesity Taskforce* (IOTF), a charity set up by Professor Philip James. It was under his tutelage that I first began to examine the post-War physical activity literature so as better to understand whether the then prevailing public health advice (summarised as 5 X 30 minutes/wk 'brisk walks') was appropriate and adequate to tackle the growing 'obesity epidemic'. This work culminated in two articles published in *Obesity Reviews*, of which I was the lead author, and the first of which can be found in the bibliography.

My lack of a formal scientific training, and my academic and journalistic backgrounds may all have influenced my initial theoretical focus, which was to concentrate exclusively on the evaluation of 'scientific evidence' within this literature while seeking a 'macro-economic' explanation for its policy interpretation. However, it became clear, after reading Garrety's examination of Ancel Keys and his cholesterol hypothesis, that there may well be in my study a similar important role for 'personalities' in shaping events. Further, as my research progressed, a series of face to face interviews in 2007 confirmed the personal influence of a small group of investigators, and most notably Steven Blair, who played an important role in shaping US public health guidelines on physical activity and health, and the 1996 US Surgeon General's Report itself.

3.1.1.1 Literature Search

This long 'atheoretical' background in history and journalism (which predated the Internet era) meant that my initial scientific literature search methods might be described as 'logical but intuitive' – in that Professor James at IOTF thrust a few of the leading papers and authors into my hands (Morris and Paffenbarger, for example) which I read thoroughly, and then devoured all the references in a 'snowball' technique. This was, of course, subsequently supplemented by continual PubMed (Medline) searches both at IOTF and during research for this dissertation. Chosen search terms included: physical activity, occupational energy expenditure, leisure time physical activity, exercise, energy expenditure, physical fitness, exercise intensity, exercise

duration, exercise frequency- each matched with outcomes that included: health, cardiovascular disease, heart disease, all-cause mortality. Searches by author included: Morris JN, Paffenbarger RS, Blair SN, Powell KE, Pate R, Haskell W, Leon A, Shaper, G, and Slattery M.

There were no formal exclusion criteria and I cannot recall precisely how many papers were searched over the many years of this study (IOTF and part-time DPhil degree), but it will have run into several hundred of which at least the abstracts were read. The bibliography, which consists primarily of scientific papers read in full contains more than 175 entries.

3.1.2 Qualitative Interviews

The qualitative interviews were handled similarly, using a simple 'snowball' technique. While the number of interviews undertaken was not large, I believe all of the most important contributors to the science and policy debates, not least Steven Blair, Ken Powell and Adele Franks, were interviewed by me (face-to-face and by email) on more than one occasion. Fortunately, I was also able to interview Professor Morris and Dr Paffenbarger at some length before their recent deaths. Had time and finances afforded, I would have wished to interview William Haskell and Russell Pate. The only person who declined my request for an interview was Carl Caspersen at the Centers for Disease Control and Prevention. While I am now familiar with academic interview techniques, such as those articulated by Kvale (**Kvale S 1996**), I relied, not surprisingly perhaps, on the interview skills and techniques I had built up in my career as a journalist in both the printed media and in broadcasting on radio and television. However, Kvale's description of the interviewer as both 'a miner and traveller' would seem particularly apt. (**op cit pp 3-4**)

3.1.3 Case Study Design

Similarly again, the use of the 'case study' design emerged, as described above, more organically than by design. But with hindsight, and after some examination of the work of Yin on the design and methods of case study research (**Yin RK 2003**) it does seem to have been the most obvious and appropriate choice. Mine have been very much 'how and why' questions. I required, nor desired any control over what were, historically, recent events. But, as with the methods of oral and contemporary history, use of face-to-face interviews proved essential. (**op cit pp 4-10 and pp 58-59**)

3.2 Chosen Theoretical Tools

It was suggested in the previous chapter that scientific public health guidelines, and not least those for physical activity, fit comfortably within the realm and definition of 'Regulatory Science' where: "Decisions frequently need to be taken even though facts are uncertain, values are in dispute, levels of trust are low, stakes are high and decisions are urgent." (**Funtowicz and Ravetz 1993**). In these circumstances it is plausible that science policy decisions may be 'hybrids', - formulated from a mixture of scientific and non-scientific (social) factors.

Nevertheless a constant consideration that will be juxtaposed to the research questions is: Was it possible that the intensity of energy expenditure and the health outcome foci of the guidelines were decided on sound, uncontested scientific grounds alone? However, a *prima facie* case has already been made which suggests that social elements, which may be disentangled, and made explicit from scientific elements, did play a significant role in the guidelines' construction. Therefore, a broad Realist Constructivist approach has been chosen as the primary guiding theoretical framework of this dissertation. More specifically and within this approach, the techniques of the political Sociology of Scientific Knowledge (**pSSK**) will be employed to analyse the apparent ambiguities, uncertainties and anomalies that may have arisen from the scientific evidence in the literature as well as any anomalies in the way that evidence was selectively or opportunistically evaluated, interpreted and used to underpin and determine public health physical activity policy. Of specific interest will be uncertainties which allow multiple interpretations, yet because of implicit or explicit assumptions, those interpretations, rather than being varied, were consistent in their repetition. Further, were data favourable to a particular interpretation consistently and disproportionately or selectively emphasised at the expense of data which did not support the favoured interpretation? Most commonly, when case studies are examined using the pSSK technique the forces causing such 'selective interpretation' of the evidence base are 'external' and of a macro-economic nature. However, in this case it would appear that external macro-economic forces were not significantly at work and that if the evidence base was selectively interpreted, the distortions may have come 'internally' from both investigators and policy makers.

Therefore, it may well be that elements of Actor-Network Theory will be employed to examine whether and how individual scientists may have used their powers of persuasion, above and beyond that arising from reliable scientific evidence, to influence public health policy decisions in formulating physical activity guidelines. If so, were the motives 'external' and 'macro-economic', or 'internal' and arising more from competition to influence public health policy for reasons that were not primarily financial? If so were those ways more beneficial to public health and/or to the pursuit of 'fame'? Were decisions solely made and justified on the reliability of the scientific evidence or was some evidence given greater weight because its value was argued more persuasively with a more convincing rhetoric?

3.3 Application of the political Sociology of Scientific Knowledge (pSSK) and 'Realist' Actor-Network Theory

Data gathering consisted initially of a textual scrutiny of archived and other relevant documents aided by a thorough search under the provisions of the US Freedom of Information Act (FOIA). That search was guided by initial hypotheses, but it was also open to other contrary indications or possible lines of enquiry as and when they emerged. These included evidence that there were data gaps in the science base upon which the *US Surgeon General's Report on Physical Activity and Health 1996* (**USSG 1996**) was based. Evidence of the extent to which the civil servants and external scientific investigators (drafted into the taskforce) expressed concerns about such gaps, uncertainties and omissions was also sought. Second, evidence about whether there were conflicts (among both civil servants and investigators) over interpretations of the scientific evidence, given the gaps, inconsistencies, and the attitudes of the participants themselves toward, or against, various elements of the physical activity guidelines was also sought. Third, how all those considerations may have influenced the selection and interpretation of the evidence which under-pinned the guidelines' construction was also examined. The structure of subsequent chapters is intended to reflect that systematic procedure.

Fourth, and as far as possible, the manner and methods of selection of the key investigators to serve on the Surgeon General's taskforce was explored. Fifth, it was important to examine the extent to which potentially valuable scientific evidence may have been omitted, ignored or significantly undervalued. The reasons for excluding or discounting certain types of data, studies or other bodies of evidence might be of

several different kinds. One possibility is that US officials and experts discounted or under-valued work produced by non-US scholars and/or in non-US publications. Another may have been that investigators who disagreed with the prevailing majority opinion about the benefits of various 'dose-response' patterns of exercise to health outcomes may have been excluded from the decision making process surrounding the guidelines' construction.

Sixth, evidence was sought on whether the deliberations and conclusions of the civil servants and investigators may have been influenced by any outside interests, not least the American Heart Association (and other 'disease lobbies'), as well as from other, commercial organisations which may have hoped to benefit financially from the Report's conclusions.

On the basis of analyses of those bodies of documentation, a set of interim hypotheses were developed concerning how the 1996 physical activity guidelines were constructed and modified. These interim hypotheses were then tested against a second data set that was derived from semi-structured interviews conducted with key protagonists, including both participating civil servants and scientific investigators. The two sets of data (archives and interviews) were then triangulated to determine which conclusions were best supported by the evidence, which were less strongly supported, and (perhaps) those that were not supported at all.

The overall methodology entailed implementing those approaches, and thereby enabling some of these possible social factors that may have influenced policy (including any key interest groups) to be uncovered and explored, and also to explore any inter-actions between them. This process, which required both data gathering, and interpretation of that data, included the following sources of documentation and information.

3.4 Sources of Documentation and Information

3.4.1 Scientific Literature

It will be essential, therefore, to examine in detail the major scientific studies beginning in the post World War II period that both reflected and under-pinned the growing interest in the impact of physical activity – and inactivity – first in the workplace, and subsequently during leisure time upon human health outcomes. It will important to

determine whether, for example, data were, in certain circumstances, ambiguous but were, nevertheless, represented as if they were unambiguous, or data which appears uncertain in its conclusions were interpreted as if unproblematically certain. Further, were data misinterpreted to such a degree that the conclusions drawn from them were clearly at odds with the scientific data actually available.

3.4.1.1 Epidemiological Studies 1948-1996

A systematic literature review using Medline and the library of the London School of Hygiene and Tropical Medicine has revealed an increasingly rich seam of epidemiological investigations into physical activity and human health, beginning in 1948 and continuing right up to, and after publication of the US Surgeon General's 1996 Report. Key words used in the electronic search included: physical activity/exercise and all cause mortality, coronary heart and cardiovascular disease; energy expenditure/exercise intensity and health outcomes. A secondary search was also undertaken using the references from those studies. Almost all of the early work, beginning with the **Framingham Heart Study (1948)** and **Morris et al (1953)** appears to have concentrated on cardiovascular disease (CVD). While research expanded to other diseases and conditions throughout the 1980s and 1990s, the scope of this dissertation must be limited largely to analysing studies on CVD and all-cause mortality, and to examination of whether undue focus may have been placed upon CVD in the US Surgeon General's 1996 Report.

Preliminary examination of the literature suggests that much of the important work was carried out by a relatively few teams of investigators, especially in the earlier years and consequently this discussion will focus on an examination and comparison of their principal studies which are repeatedly referenced in the literature.

Almost all of the early epidemiologic investigations appear to have involved occupational/workplace studies with cohorts typically of white males whose intensities and volumes of energy expenditure varied between sub-groups of employees. It may be important to attempt to identify whether these differing study designs and these cohorts are easily comparable, or whether differences in these and other characteristics make comparisons and evaluation of results difficult, incomplete and uncertain. For example, it is already evident that some investigators focused primarily on total volume of expenditure while others looked at intensity or a mixture of both. These difficulties appear to have been made more acute by the decision, in the 1970s, by investigators to focus attention, not on occupational but on leisure time physical

activity (LTPA) – energy expenditure which was harder to classify, recall or measure than that done in the workplace. Some investigators chose to rely on self-report questionnaires, while others relied upon baseline fitness tests to measure their cohort's activities, and it will be worth taking those differences into account.

In both the early occupational and LTPA investigations, the principal health outcome examined was the cardiovascular diseases. Reasons, both explicit and implicit will be sought from the literature as to whether, and if so why, that narrow focus was adopted, to the possible detriment of knowledge gained about the impact of physical activity on other important health outcomes.

Finally, it may be illuminating to examine how the research agenda and interpretation of data may have begun to change as the principal investigators began to succeed, and saw themselves succeeding, in establishing physical activity as a front rank public health tool to prevent and/or reduce the incidence and severity of the cardiovascular and other important diseases.

3.4.1.2 Intervention Studies in the 1990s

Considerable attention will also be paid to two large and important intervention studies that were conducted and published in 1991 (**Duncan et al 1991**) and 1995 (**King et al 1995**) – not least because they may shed some light on the important public health issue of population adherence to varying exercise guidelines and prescriptions. For example, it may be illuminating to examine the evidence base for claims made that the American public were deterred from undertaking vigorous activity programmes, and were much more likely to adhere to less arduous and more flexible forms of physical activity. It may also be of interest to examine whether, and for what reasons, in both studies, emphasis and focus may have been placed on one risk factor for heart disease to the relative exclusion of other risk factors for heart disease and other health outcomes.

3.4.2 Policy Literature

3.4.2.1 The Primary Workshops, Conferences and Position Papers

The US Centers for Disease Control and Prevention (CDC) held its first significant workshop on physical activity and health in 1984. Several of the more important papers from this seminal event will be examined in detail. Thereafter a host of workshops, conferences and position papers were issued by the American Heart Association, the

American College of Sports Medicine and US Government Agencies (the CDC and the National Heart, Lung and Blood Institute of the US National Institutes of Health). Those too will be examined in detail.

3.4.2.2 The 'Grey Material': Unpublished background policy documents

Efforts were made to obtain all unpublished background material pertaining to the National Institutes of Health 'Consensus' Conference (1995) on physical activity and cardiovascular disease and to the US Surgeon General's 1996 Report itself. These efforts included direct approaches to appropriate civil servants/policy makers and via the formal procedures of the US Freedom of Information Act (FOIA).

A thorough review of the literature, both published and unpublished, allowed the articulation of provisional hypotheses that could help explain the construction of, and changes to, the US post World War II public health physical activity guidelines. Thereafter, semi-structured personal interviews were sought with key civil servants/policy makers and scientific investigators. The purpose of the interviews was to help to clarify and then select from the possible (and often competing) hypotheses and further to try to illuminate, explain and resolve the various uncertainties, ambiguities, inconsistencies and anomalies that are likely to have arisen from the literature.

3.4.2.3 *Physical Activity and Health: The Surgeon General's Report 1996*

The 300+page Report, the first on physical activity published by the US Surgeon General, was to become the definitive document underpinning US public health policy on the importance of physical activity at the end of the 20th century and into the next. The Report too will be scrutinised, under the theoretical frameworks and the methods already described, to determine whether it was based solely and accurately on the available scientific evidence, or whether 'social' factors, both 'external' (including political ones) and 'internal', also determined its content, interpretations and recommendations. For example, were any relevant data and/or entire studies underplayed, misinterpreted or even omitted – and if so, was there a discernable pattern to these occurrences which might indicate that social factors, such as a desire to support one energy expenditure/activity hypothesis over a competing one, may have influenced the Report's final recommendations?

3.4.3 Personal Interviews with Key Civil Servants/Policy Makers and Senior Scientific Investigators.

These semi-structured interviews, while relatively few in number, were intended to include individuals with the greatest knowledge about the preparation and construction of the US Surgeon General's 1996 Report (**USSG 1996**) as well as the most highly regarded and prolific scientific investigators in the field of physical activity and health, and public health, some of whom also became policy makers as senior members of the Surgeon General's taskforce appointed by the CDC. As has been explained, the interviews were intended to help examine and explain some, if not all, of the knowledge gaps and inconsistencies which are likely to remain even after thorough analyses of both the published and unpublished background documents. Most particularly, it was expected that the interviews might help to reveal and explain whether some of these knowledge gaps, inconsistencies – and even conflicts and anomalies – arose from non scientific (social) factors and to identify what these factors were.

The interviews listed below, both with civil servants/policy makers, and scientific investigators were pivotal to this research and every effort was made to seek their co-operation, when it has not already been granted. Of course, further interviews with other individuals could also be valuable, but were not possible in the time available. It was illuminating to see the extent to which interviewees contradicted not only aspects of the literature, but also each other, in their interpretations of documents, discussions and policy decisions –and why – and whether some accounts seemed more reliable than others.

3.4.3.1 Civil Servants/Policy Makers

Terry Bazzarre Senior Scientist, Head of Nutrition and Physical Activity, American Heart Association. May 2007, Princeton, New Jersey. Subsequent email communications.

Steven Blair Senior Scientific Editor, *US Surgeon General's Report on Physical Activity and Health (1996)* November 2004, September 2006 October 2007 all London, England. Frequent email communication.

Adele Franks Physician (MD) Scientific Editor, *US Surgeon General's Report on Physical Activity and Health (1996)* Assistant Director for Science National Center for Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. May 2007, Northampton

Massachusetts. Frequent email communication.

Ken Powell Founding Chief of Behavioral, Epidemiology and Evaluation Branch
Division of Health Education, Center for Health Promotion and
Education, Centers for Disease Control and Prevention. May 2007
Atlanta, Georgia. Subsequent email communications.

Michael Pratt Senior Medical Epidemiologist, Division of Nutrition and Physical
Activity, Centers for Disease Control and Prevention. January 2007
Telephone Interview, Worcester, England to Atlanta, Georgia.

3.4.3.2 Principal Scientific Investigators interviewed

Steven Blair PED The Cooper Institute, Dallas, Texas.
November 2004, September 2006, October 2007, London,
England.
Frequent email communication

Jeremy Morris MD The London School of Hygiene and Tropical Medicine.
April 2004, December 2006 London, England

Ralph Paffenbarger MD Stanford University, California, August 2002
Berkeley, California and previous conference meetings

Paul Williams PhD Lawrence Berkeley Laboratory, Berkeley, California
email communications 2007

Richard Winett MD Virginia Polytechnic Institute and State University
email communications 2007

Chapter 4: The Early Investigators: Occupational Energy Expenditure

4 Introduction

This chapter initiates the chronological textual scrutiny referred to in Chapter 3, and reviews the published studies on the putative links between physical activity and health outcomes, by looking at the early post-World War II pioneers in the emerging field of physical activity, health and chronic disease epidemiology. It attempts to explore their methods of scientific enquiry in occupational studies of men at work. The studies of the early investigators, both in Britain and the United States, laid the groundwork, it will be argued, for the emergence of physical activity as a front rank public health tool for the prevention or reduction of disease and the promotion of healthier lifestyles.

4.1 The Pioneering Work of Jeremy Morris

4.1.1 'The London Busmen Study'

Morris' landmark investigation, *Coronary Heart-Disease and Physical Activity of Work*, **(Morris et al 1953)** was first reported in the *Lancet* medical journal in two linked articles and concerned the study of around 31,000 male London Transport staff (aged 35 to 64)) who were either drivers or conductors/guards on the city's buses, trams and underground railways. Primarily, Morris focused on the drivers and conductors of London's inner city 'double-decker' buses. His primary research question was: Did the greater physical activity of the conductors give them greater protection from heart disease than their sedentary driver companions. Drivers sat at the wheel of the London buses all day while their conductor colleagues climbed up and down the stairs to the upper deck to collect fares. Today bus fares in London are mostly paid by some means of pre- paid (card or electronic) collection. But in the 1950s conductors on the double-deckers would have needed to climb the eight twisting steps roughly ten times an hour at the very least to collect fares. **(private communication with London Transport Museum, Covent Garden, 2001)** The bus conductors were obliged, therefore, to engage in much greater physical activity at work than their driver colleagues.

Morris also set out to see whether there might be any confounding independent variables

between his two groups of sedentary and active subjects. He established that the bus drivers and conductors came from similar ethnic groups, neighbourhoods and social backgrounds. They lived in the same communities and earned much the same weekly wages. Their smoking patterns were not significantly different. Morris reported that the men were “from the same part of the country, served by the same health and welfare services and living in broadly similar circumstances.” **(Morris et al 1953 p 1055)** And yet, the heart attack rate of the two groups (drivers, and conductors) was significantly different. The total annual incidence of heart attacks (defined as ‘clinical episodes of heart disease’) among drivers was 2.7 per thousand compared to 1.9 among conductors. When immediate deaths alone were examined **(Figure 4.1)** the comparison was even more striking with drivers dying at more than twice the rate (0.9) as conductors (0.4).



Source: **Morris et al (1953)** Table III, p 1055

Morris and colleagues concluded:

“The conductors had less coronary heart-disease than the drivers, and the disease seemed to be appearing in them at a later age. What disease the conductors had was less severe: they had a smaller early-case fatality as well as a lower incidence, and therefore they had a substantially lower early mortality-rate.” **(op cit p 1055)**

Morris strengthened his argument by showing that the conductors also had a higher rate of angina pectoris than their driver colleagues. This may seem perverse. But, as he

explained, angina is a relatively mild early-warning, and thus often a life-saving signal of heart disease which is more commonly discovered quickly when an individual is involved in vigorous physical exertion, such as frequent, repetitive stair climbing. This was further evidence to Morris that the vigorously active conductors were more able to spot signs of heart disease at an early stage and therefore to find treatment quickly, and thus to avert sudden death from a severe heart attack.

Morris further sought to examine whether the London bus drivers and conductors might have differences in their 'constitutions', or were in some way self-selecting in their choice of jobs (drivers v conductors); whether the different psychological stresses ('mental strains') of the two occupations could significantly account for the differences in cardiac morbidity and sudden deaths from heart attacks, or whether it was safe to conclude that the differences in physical activity were sufficient to explain the lower heart attack rate among conductors. He observed:

"It is easy to imagine *all* of these influences contributing to the difference of experience observed (and there may be more)." But Morris and his co-authors concluded: "This last proposition – that the physical effort in the conductors' work may be a protective factor in middle age from some of the worst manifestations of coronary heart-disease suffered by less active workers – attracts us most, because it offers special opportunities for study. We therefore decided to focus on it for a start, and to ignore the other factors in the constitution of the men and in their history that must certainly also be involved."
(**op cit p 1056**)

4.1.2 London Postal Workers: The Physical Activity Hypothesis Re-tested

Morris went on to extend his study (and re-test his hypothesis) by examining the heart attack rates of London postal and telephone workers, comparing those who walked rounds delivering letters (active postman) and those male operators who sat connecting calls (telephonists). The results were strikingly similar. The incidence of active postmen dying within 3 months of a heart attack was roughly half of the incidence seen in inactive telephonists. (**op cit p 1112**) Morris took two further steps to test his physical activity hypothesis. He and his colleagues examined the occupational mortality data of the UK Registrar General for 1930-32: "the latest (and only) years that could be studied....(and)

this showed that at 45-64 years of age heavy workers had half the mortality from heart disease of light workers.” **(op cit p 1113, p 1120)** A further examination of death certificates from heart disease by occupation in London and the Home Counties during March 1952 broadly confirmed the analysis that workers in “heavy” jobs died less often than those in “light” exercise work. **(op cit p 1120)**

Morris and colleagues also questioned whether psychological factors might be confounders:

“It is possible that psychological variables, such as work satisfaction and frustration, the presence or absence of anxiety, emotional equilibrium, or personality integration, are correlated with physical activity at work; and they may be in part produced by it. But it seems unlikely that the relation between such psychological aspects and physical activity can be close and regular enough to explain in psychological terms the association with coronary heart disease that was found (a) in such a variety of occupations and (b) in such a diversity of psychological situations.” **(op cit p 1118)**

Indeed, Morris argued that physical activity might even have a beneficial effect on levels of psychological stress – a theory much in advance of its time **(see USSG 1996 p137 and p140)**:

“Nevertheless, it is quite conceivable that at a biological level, physical activity in work performs a stabilising function (for example in channelling so-called aggressive drives) and this may be important in highly civilised societies and, for all we know, may be particularly relevant to conditions such as coronary heart-disease.” **(Morris et al 1953 p 1118)**

Morris and his colleagues chose then, on the evidence, to minimise the importance of these confounders. Thus, they observed in their provisional hypothesis and subsequently in their summary of conclusions that:

“Men in physically active jobs have a lower incidence of coronary-disease in middle age than have men in physically inactive jobs. More important, the disease is not so severe in physically active workers, tending to present first in them angina pectoris and other relatively benign forms, and to have a smaller early case-fatality and a lower early mortality rate.” **(op cit p 1120)**

Further, Morris then went on to forecast the importance of discretionary, leisure-time physical activity in heart disease prevention among the growing number of people – even in the early 1950s – who were losing their heavy manual jobs to mechanisation. He said that his findings were, of course, “still hypothesis rather than established fact – at most an association...rather than a causal connection.” Yet, he observed:

“It can, however, be pointed out that they may be relevant to the suggestion that there has been a real increase of coronary heart-disease in recent years – i.e., during a period in which heaviness and hours of work have declined; during the second Industrial Revolution with its new sources of power....with increasing numbers of men engaged in management, administration, and the bureaucracy.....Meanwhile, we need evidence as to whether physical activity *outside* work (this may well also have diminished in recent years) in exercise and games, for example, can compensate for lack of physical activity *in* work.”

(op cit p 1120)

Morris' investigations into physical activity and heart disease shaped the scientific and public health debate for the next fifty years. Indeed, the authors of the 1996 *US Surgeon General's report on Physical Activity and Health* (**USSG 1996**) described the work of Morris and his colleagues as a “landmark” in the scientific study of the impact of physical activity on health outcomes. (**USSG 1996 p 15**). His prescience can also be seen from the transcript of a broadcast he made in 1955 on BBC radio on his post-War vision of public health, chronic, preventable disease and individual lifestyle changes:

“.....we are dealing with a different social situation. The 19th century epidemics bred in poverty and malnutrition, arose from failures of the social system. The wave of tuberculosis that followed the industrial revolution and the ubiquitous rickets of the Victorian slums could be regarded as passing faults of society; there was hope and confidence that further social progress would mitigate against and in its time abolish such evils. But coronary thrombosis.....with its origins apparently in high living standards....seems to be arising from what we regard as successes of the social system, and from the essential processes of our new industrial society....It is becoming clear that in the modification of personal behaviour, of diet, smoking, physical exercise and the rest, which look like providing at any rate part of the answer, the responsibility of the individual for his own health will be far greater than formerly. It will not be

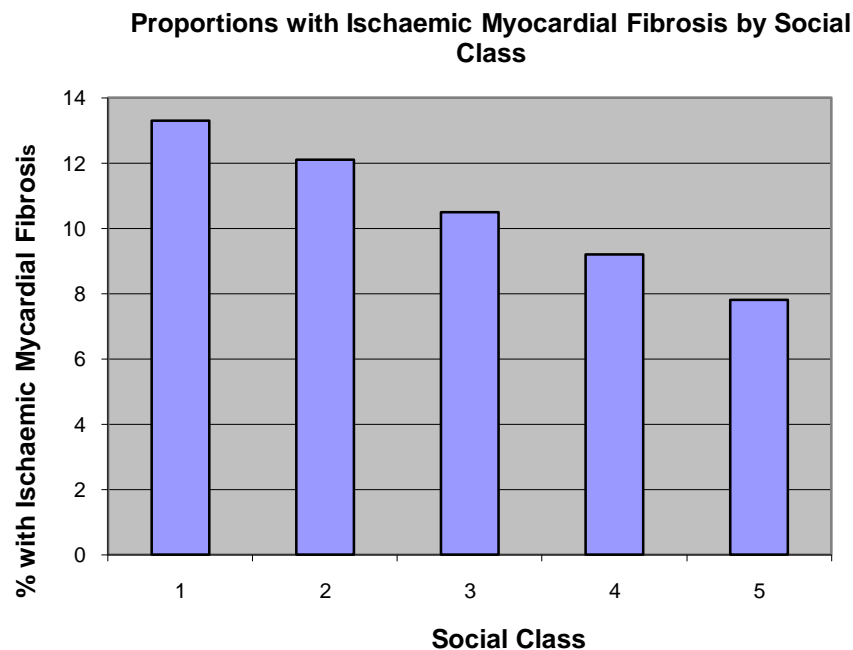
possible to impose from without (as drains were built) the new norms of behaviour better serving the needs of middle and old age. They will only come about in a new kind of partnership between community and individual.” **(Morris JN 1955)**

4.1.3 The Links Between Physical Activity, Heart Disease and Social Class

Morris returned to these early occupational investigations when he again examined the association between coronary heart disease and physical activity at work, but this time by a different route: necropsy and social class. With Margaret Crawford, a fellow physician at the Social Medicine Research Unit of the Medical Research Council in London, he appealed to pathologists from all over Britain to supply them with post mortem data on male hearts that they had recently examined. **(Morris and Crawford 1958)**. They asked: “Can the hearts of men be seen to vary with the kind of work they have done?” **(Morris and Crawford 1956 p 1485)**

More generally, Morris and Crawford intended also to uncover a snapshot of British male coronary arteries (circa 1954-56) among those men who had not died from coronary heart disease (CHD). By this method they hoped to discover just how endemic heart disease (even when not fatal) there was throughout the UK population by assessing myocardium for fibrosis induced by previous ischaemia. They then classified those data according to the occupations and social classes of the deceased as set out by UK government statistics **(General Register Office Classification of Occupations, 1950)**. Their findings **(Figure 4.2)** revealed a significant ($p < 0.01$) inverse linear trend showing that myocardial fibrosis was most frequent among the highest social class (1) which also did the least heavy work. Further, the condition was least common among the lowest social class (5) which did the most occupational labour.

Figure 4.2



Source: Data taken from **Morris and Crawford (1958)** Table IX p 1490. A total of 3,800 non-coronary deaths in males aged between 45 and 70 years were examined for evidence of ischaemic myocardial fibrosis and the results analysed by social class. The trend of the proportions with ischaemic myocardial fibrosis is significant at $p < 0.01$. Occupations were allocated to a social class in accordance with the General Register Office Classifications of Occupations, 1950

Once again the analyses of Morris and his co-author were insightful and prescient of later research into sedentary lifestyles, most notably by Paffenbarger and Blair. Morris and Crawford suggested: “....the *speculation* may be advanced that habitual physical activity is a general factor of cardiovascular health in middle-age, and that coronary heart disease is in some respects a deprivation syndrome, a deficiency disease.” (**op cit p 1495**). Morris and Crawford suggested, therefore, that physical activity was protective against heart disease and heart attack death. Conversely, they hypothesised that physical inactivity (sedentary lifestyle) was a potent contributor to cardiovascular disease.

4.1.3.1 Emergence of the arguments and elements that would define future public health physical activity guidelines.

In terms of shaping and influencing the coming public health debate, and construction of physical activity guidelines, these early findings by Morris and Crawford would prove to be of considerable importance because they examined and reported upon many of the key

issues that would remain central to future investigations in the field. In effect, Morris and Crawford demonstrated that the most sedentary males in the highest social class were most likely to develop myocardial fibrosis whether or not they subsequently died from cardiovascular disease. Here then was apparently clear evidence that men in the highest social class were most susceptible to heart disease which might be prevented, for example through public health guidelines and campaigns, if they became less sedentary and engaged in more discretionary, leisure-time physical activity. The empirical trend by class (the authors' proxy for energy expenditure) was linear and there was no apparent minimum threshold of occupational activity needed to induce a decline in the percentage across classes with myocardial fibrosis. Physical activity was not only beneficial. Its absence, in sedentary occupations, was positively detrimental to heart health.

This investigation by Morris and Crawford contained three further observations which would have important implications for the study of physical activity and its effect on coronary heart disease and subsequently, other health outcomes: first, and most obviously, their results appear to have implied that the association between physical activity and heart disease was, broadly, linear. Morris' previous ('two point') studies with busmen and postmen had primarily compared simply active men (conductors and postmen) with their inactive colleagues (drivers and telephonists).

Second, they concluded from this necropsy study that physical activity, while playing a significant role in the reduced incidence of myocardial infarctions (death of heart muscle caused by thrombosis or blood clot), did not apparently affect the other major cause of heart disease and heart attacks – atherosclerosis (clogging or hardening of the arteries caused by plaques or fatty deposits). They observed: "Clearly the main causes of coronary atherosclerosis in man have to be sought elsewhere – for example, in hypertension and, the principal field of interest at present, in diet and lipid metabolism." (**op cit p 1494**)

Thirdly, Morris and Crawford made a further advance in public health terms when they again questioned, apparently well in advance of other investigators, whether *leisure time* physical activity (as opposed to occupational) should (and could) be amassed and measured to determine whether it too had similar impact on cardiac and other health and disease outcome.

“Then, it may be asked whether regular physical activity *outside* work protects against coronary heart disease in middle-age. There is no information, meanwhile, on the relations, if any, between physical exertion in leisure, for example, and the incidence or prevalence of coronary heart disease; but plainly this is the main implication of observations such as the present for preventive medicine, and means of testing such a hypothesis must be found.”

(op cit p 1493)

By focusing on the prospect of large scale leisure-time investigations, Morris was also effectively laying the ground for the construction of public health guidelines for physical activity. If these voluntary activities could be accurately captured, measured and evaluated by doctors and relevant scientists, evidence might then be found to guide populations with recommendations to choose exercises and/or less structured (lifestyle) leisure activities that had been shown to reduce the risk of cardiac and other chronic diseases and conditions. Since the vast majority of large scale work forces in Britain were young-to-middle aged white males, early occupational studies, which relied on employer generated data, effectively excluded large scale study of women, ethnic minorities and the elderly. Leisure time studies, which would broadly rely on self-reported data (Morris’ “*ad hoc* studies of large numbers of individuals”) would not be constrained by gender, age or ethnic group, if investigators chose to include them. Equally, guidelines informed by such evidence, might then be better tailored to the needs of differing individuals.

4.1.3.2 Dose/Response: Linear or Curvilinear? Threshold or Total Volume?

Morris and subsequent investigators would continue, both in epidemiological and (later) intervention studies, to confirm a broad and positive association between physical activity and various health outcomes. However, debate would soon begin as to whether the inverse trend (perhaps beginning at a certain minimum threshold of intensity or volume of energy expenditure) was linear, as Morris and Crawford observed, or concave curvilinear - where greatest benefits were seen between sedentary and the next least sedentary subjects, while decreasing benefits were observed between active and the most active or fittest subjects. Similarly, (as indicated above) a debate would also emerge over whether a minimum threshold of physical activity, as measured by intensity or total kcal volume of energy expenditure per minute, was needed to observe a measurable effect. This conflicting evidence would subsequently inform the public health case for moderate

intensity versus vigorous activity guidelines, and also the development of ‘dose-response’ analyses to delineate the most important measures (total amount, intensity, duration, and frequency) of physical activity needed to impact most successfully in various health outcomes.

4.2 Early Studies in the United States 1962 -1970 Taylor and Paffenbarger

The discussion now turns to exploring what impact the investigations by Morris and his colleagues in Britain may have had on others in the scientific community who may have been preparing similar, but as yet unpublished investigations in the United States.

Morris’ work appears to have encouraged at least two teams of American investigators to continue or to undertake similar occupational studies about physical activity in the United States. Henry Taylor and colleagues (**Taylor et al 1962**) studied railway employees. Ralph Paffenbarger and colleagues (**Paffenbarger et al 1970**) examined ‘longshoremen’ (dock workers) in San Francisco. Paffenbarger would also continue to follow, reflect and advance the work of Morris over the next three decades as they became both academic competitors and close friends. (**personal communications with JN Morris and RS Paffenbarger, 2001-2006**)

4.2.1 Heart Disease and Diet: Ancel Keys

Turning first to the work of Henry Taylor (**Taylor et al 1962**), it is important to note that one of the key authors of this seminal study on American railwaymen was Taylor’s colleague, Ancel Keys, whose primary interests lay in nutrition. Further, that relevant nutrition data taken from this work would also (in the guise of the *US Railroad Study*) become part of Key’s well documented *Seven Countries Study* (**Keys et al 1984**) on diet and heart disease. (**Blackburn H 2007**) While Morris, and then Paffenbarger would effectively lead investigation into the effects of physical activity on human health, so too, in a very similar way, Keys led the post war examination of diet on health and mortality with his investigation into saturated fats, dietary cholesterol and heart disease. (**Keys A 1952**) Like Morris, Keys saw an early association between an environmental variable (physical activity, unsaturated fats) and a clear reduction in death rate from heart attacks – at least among white American and European males. Keys’ success in influencing the American

Heart Association (AHA) to support his 'cholesterol hypothesis' will also be compared (see Chapter 10) with similar steps taken in a later decade by Steven Blair to win the AHA over to his 'moderate intensity physical activity hypothesis'.

4.2.2 Taylor et al 1962

Taylor and colleagues (**Taylor et al 1962**) chose railwaymen working in the 1950s because these employees offered what the investigators described as 'a favourable epidemiological laboratory' for three primary reasons: occupational mobility was low; a large and distinct pool of sedentary, moderately active and vigorously active men could be studied; the US Railroad Retirement Board kept unusually accurate and reliable death rate data.

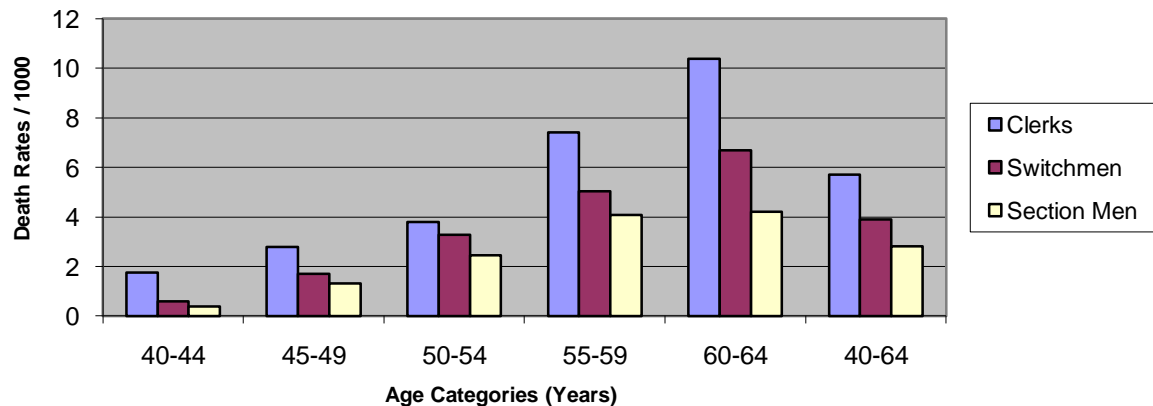
Once again, the primary health focus for Taylor and colleagues was heart disease and in the opening paragraphs of their account of their investigation they made reference to the earlier work of Morris and his colleagues. (**op cit p 1697**) There can be no doubt that, even at that stage, investigators from both sides of the Atlantic were acutely aware of each other's work. (**personal communications with RS Paffenbarger 2001 and 2002 and JN Morris April 2004**)

4.2.2.1 Moderate versus Vigorous Physical Activity: the first major comparison

The broad conclusions of Taylor and his colleagues concerning the relevance of occupational physical activity to mortality and morbidity were consistent with the occupational findings of Morris' British group. The American team divided the railwaymen, aged 40-64, into three categories: sedentary clerks, moderately active 'switchmen' (or 'signalmen') who worked in the railway yards, and the most vigorously active 'section men' who worked repairing track along the lines (**Figure 4.3**). They concluded: "The results reported are consistent with the hypothesis that men in occupations requiring at least moderate amounts of physical activity have fewer fatalities from coronary heart disease than do men in sedentary occupations."

Figure 4.3

**Mortality Rates Ascribed to Arteriosclerotic Heart Disease in US Railway
Workers, 1955-56**



Source: **Taylor et al (1962)** Table 4 p 1701. The men studied had acquired 114 months of service by December 1951, were still working in 1954 and were from 40 to 64 years of age. They were divided into three job classifications: clerks, switchmen (outdoor railway yard workers) and section men (track labourers), with clerks being the most sedentary and section men the most vigorously active. A total of 191,609 man years were studied. Numbers are deaths per 1,000. Combined data (40-64 year age category) are age adjusted.

Furthermore, because Taylor and colleagues measured the death rates from heart disease for three classifications of work intensity, they were, unlike Morris, able to compare not only sedentary populations (clerks) with the moderately active (switchmen) – but also to compare the status of the more vigorously active section men with the other two groups. Their results show that the death rate per 1,000 for sedentary clerks was 5.7, for moderately active switchmen 3.9, and for the most vigorously active section men, 2.8.

Thus the relative merits of moderate versus vigorous activity in reducing deaths from heart disease was reported in a major study for the first time. However, this apparent and approximate linear relationship showing the significant and substantial superiority of vigorous over moderate activity would not always be replicated in future studies using different populations, design methods and health outcomes.

As has been mentioned, Morris and colleagues chose only male London busmen as their cohort. Although they did not mention ethnic or racial origin, this may simply have been an oversight on their part, since London busmen in the late 1940s and early 1950s (just prior

to the first major influx of immigrants from the Caribbean) would have been overwhelmingly of white, British origin. By contrast, however, Taylor and colleagues more carefully defined their cohort as “white males in the above occupations”, acknowledging in an appendix to their paper that other races were initially considered for entry but were subsequently excluded and that their study “had to be cut down to those white males who had 114 months of service in 1951.” **(Taylor et al 1962 p 1706)** Reasons for this exclusion were not given. As will be seen later in this chapter, Taylor, in the conception of the railroad study, was pioneering in two very important ways: he introduced precise, exercise treadmill tests to measure heart-rate fitness of his subjects. He also devised and administered the first modern leisure-time physical activity questionnaire. However, he never fully analysed and published these results. This would be left to a later generation of investigators, after his death. (See further discussion of Taylor’s investigations at **Slattery and Jacobs 1988**, and **Slattery et al 1989** in Chapter 7)

4.2.3 Paffenbarger et al (1970)

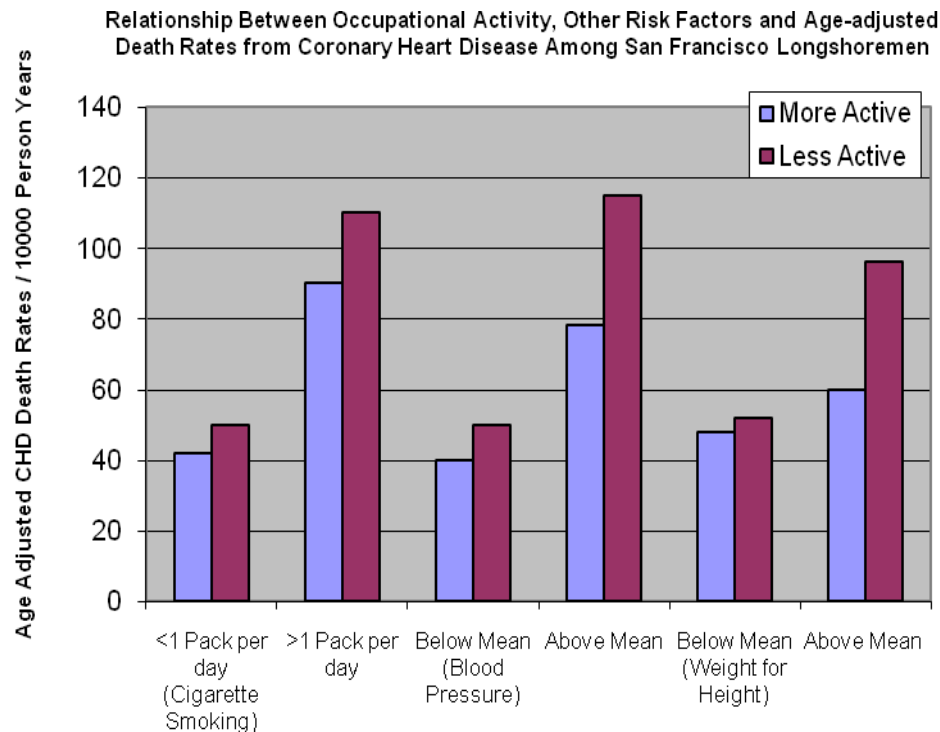
While Morris led the investigation into the impact of physical activity on health in Britain, he was to be most closely followed in the United States by Ralph Paffenbarger, also a physician (MD) and public health epidemiologist.

Paffenbarger, in the wake of Morris’ work on London busmen, was drawn to a similar examination of the dock workers (longshoremen) of San Francisco, California in the late 1960s. Like Taylor and Morris, Paffenbarger chose this cohort, in part, because they had gone through a thorough medical screening (in 1951) enabling him to establish the epidemiological data necessary to carry out his analyses of the impact of physical activity on their subsequent health. **(personal communication with RS Paffenbarger, Berkeley, California August 2002)** The results of his investigation were published in the New England Journal of Medicine **(NEJM)** in 1970 **(Paffenbarger et al 1970)**. Once again, the primary association in this 16 year follow up study was between occupational physical activity and deaths from heart disease (and stroke) among 3,263 men aged 35 to 64 at baseline.

Paffenbarger and colleagues used ‘occupational energy cost requirements’ from existing studies to measure the workloads of each job to rank them in order of energy expenditure. Again, a clear inverse association was seen between workload and deaths from coronary

heart disease – except among men older than 65 for whom death rates were equally high, regardless of energy expenditure.

The men's medical examination at baseline included not only their 'cigarette habit' (below/above packet/day), but also blood pressure and 'weight for height' (above/below mean) patterns. The 'energy cost requirements' of each class of workers (shoveler, holdman, sugarman, winch driver, cargo handler, cooper and walking boss, for example) were calculated and a weighted mean of energy expenditure was established across the population. From this mean, men were simply divided into 'more' or 'less' active categories. Those in the less active category sustained coronary death rates one third higher than the cargo handlers in the more active category. Higher than average physical activity was also protective against all three studied risk factors for heart disease deaths: cigarette smoking, blood pressure and weight for height. Furthermore, it brought protection (**Figure 4.4**) to those men whose exposure to each risk factor was above the mean (1+ pack of cigarettes per day, higher than average blood pressure, and weight for height above the mean).

Figure 4.4

Source: Data taken from **Paffenbarger et al (1970) Fig 4 p 1111**. 3,263 San Francisco 'longshoremen' (35-64 years of age) were screened for job assignment, cigarette habit, systolic blood pressure level and weight-for-height at the beginning of the study. Death rates from coronary heart disease were measured in a 16 year follow-up study with a range of person-years of experience from 18,700 to 25,900. $P < 0.05$ between two levels for systolic blood pressure and 'weight for height', but not for cigarette smoking. Risk ratios less active/more active: <1 pack 1.28, >1 pack 1.18, below mean systolic blood pressure 1.28, above mean systolic blood pressure 1.42, below mean weight for height 1.08, above mean weight for height 1.36

Paffenbarger and his colleagues broke new ground in this study by looking not only at the direct protective effect of physical activity against CHD death, but also at the protection physical activity gave against three other independent variables (smoking, blood pressure and weight) which were perceived to be risk factors for heart disease.

4.4 Chapter 4 Summary

Through their early occupational studies, Morris in Britain, and Taylor and Paffenbarger in the United States elucidated the broad importance of physical activity in the prevention of, and protection against coronary heart disease – at least among young to middle-aged

white males employed in relatively active manual jobs. Morris would also go further in speculating that research would need to be done to establish “whether regular physical activity *outside* work protects against coronary heart disease in middle-age.” **(Morris and Crawford p 1493)**. Thus, his focus shifted from the work environment, where energy expenditure was diminishing with increasing mechanisation, to the home and leisure environment where sports and other physical activity pastimes were selected and pursued. It is to Morris’ first investigations into leisure time physical activity (LTPA) and heart disease and to the issue of exercise intensity that the discussion now turns.

Chapter 5 Epidemiological Research Moves to Leisure Time Physical Activity (LTPA): Morris and Paffenbarger: 1973-1980

5 Introduction

Continuing the chronological scrutiny of the scientific literature concerning the putative public health benefits of physical activity, this chapter sets out to explain how, in switching their epidemiological investigations to leisure time physical activity (LTPA) Morris first and then Paffenbarger led the way for the study of physical activity and health (and its application) to become central to US public health thinking and policy. It examines the similarities and differences between the two investigators' methods, study designs and conclusions, with particular reference to the debate as to whether a 'minimum threshold intensity' of activity, or the 'total volume' of energy expenditure was the key element of physical activity's protective effect against heart disease.

5.1 Morris et al (1973): 'The Whitehall Study' – *Vigorous Exercise in Leisure-Time and the Incidence of Coronary Heart Disease*

Morris' working hypothesis was that physical activity at work (manual labour) was beginning radically to decline in the 1970s as mechanisation and office jobs replaced 'heavy industrial work' in the home and workplace. In addition, the motor car would replace walking to work – or even walking to public transport: "Work in advanced societies increasingly is light and sedentary, so any future contribution to public health can only come from exercise taken in leisure-time." **(Morris et al 1973 p 333)**

Morris expected to see a strong, inverse and linear association between the total volume or amount of leisure time physical activity (LTPA) reported and the incidence of heart attacks and deaths coronary heart disease (CHD) **(personal communication with the JN Morris, London April 2004)**

However, from analysis of their epidemiological data (explained below) Morris and colleagues were compelled to challenge what they called this 'classical hypothesis' that the total volume of physical activity, simply measured in kcals of energy expenditure, was the protective factor against heart disease and death from heart attacks. Instead, Morris

and colleagues put forward what they called the ‘alternative hypothesis’ – namely, that it was not total volume, but instead a minimum threshold intensity and duration of physical activity that was protective against the disease.

5.1.1 The Civil Servant Cohort

Morris and colleagues chose as their cohort, 16,882 middle aged (40-64) British male civil servants. Although nicknamed ‘The Whitehall study’ (after the road, Whitehall, housing many government departments in London), the civil servants were actually selected from six government departments sited across Britain. The civil servants reported retrospectively by questionnaire about their leisure time physical activities during a single 48 hour period on a Friday and Saturday on dates between 1968-70. In so doing Morris and colleagues were to conceive and to publish the first substantial study whose primary purpose was to explore the association between leisure time physical activity (LTPA) and a major disease outcome. This distinction is qualified in as much as the *Framingham Heart Study*, as we have seen, included leisure time physical activity among the several health variables (determinants) and risk factors it studied and continues to study. Further, as mentioned in the previous chapter, Taylor and Keys developed a leisure time energy expenditure questionnaire as part of their primary occupational examination of US railroad workers (**Taylor et al 1962**). But Taylor’s leisure time study was not terminated until 1977 and its data were not collated, evaluated and published until 1989 (after his death) by Slattery and colleagues. (**Slattery and Jacobs 1988, Slattery et al 1989**)

In his earlier occupational studies with busmen and postal workers (**Morris et al 1953**), Morris sought primarily to establish that men in physically active jobs (conductors and postmen) had fewer heart attacks than those (drivers and telephonists) in sedentary occupations. No attempt was made to measure and compare the energy expenditure of the two occupational groups, or to establish whether a minimum threshold of intensity and/or duration was necessary to achieve significant risk reduction. Now, however, Morris advanced the radical notion that only vigorous activity above a minimum intensity threshold, whether in the form of leisure exercise or physical work, was significantly protective against CHD – and hence his adoption of the ‘alternative hypothesis’ that only vigorous activity had a ‘threshold’ or training effect on the heart and cardiovascular system. Morris and colleagues concluded: “During the two sample-days, 11% of the men

who developed coronary disease, compared with 26% of the controls, reported such vigorous activities.” **(Morris et al 1973 p 333)**

5.1.2 Mechanism or ‘Biologic Plausibility’

Morris suggested a direct physiological mechanism (‘biologic plausibility’) for the vigorous hypothesis which did not involve an indirect positive effect via a reduction in known risk factors such as high blood pressure or atherosclerosis associated with high LDL serum cholesterol:

“Does the stress of habitual vigorous exercise on myocardium and coronary circulation, in a population with ubiquitous atherosclerosis, stimulate collateral proliferation and/or enlargement of the main coronary arteries? Preliminary investigation, as expected, indicates that vigorous exercise is not associated with a lower prevalence of high blood-pressure and hypercholesterolaemia; the advantage seems to be in adaptation to these.” **(op cit p 338)**

Morris defined these ‘vigorous’ activities as “those likely to reach minimum peaks of energy output of 7.5 kcal per minute” **(op cit p 334)** and listed common activities **(Table 5.1)** which he believed fitted within this category which were reported by his civil servant subjects. This definition of vigorous energy expenditure was derived, as cited, from the standard exercise physiology textbooks published between 1967 and 1970.

Table 5.1

VIGOROUS EXERCISE: MALE EXECUTIVE-GRADE CIVIL SERVANTS, AGES 40-64: SAMPLE FRIDAY AND SATURDAY, 1968-70: BRITAIN

Activity	Examples of “vigorous exercise”
Recreation	Swimming, tennis, sailing as crew, hill climbing; dancing (specified)
“Keep-fit”	Morning exercises, 5BX*
Physical Work**	
Gardening	Planting bushes, clearing scrub, felling trees; any work on own allotment
Do-it-yourself	Building in stone or concrete/demolition
Other	Moving heavy objects; major, rusted, car repairs
Getting about	Brisk walking in town, over rough country; running; cycling (not otherwise specified)**
Climbing up stairs	500+ daily

*Royal Canadian Air Force fitness system

** Spell of over 30 minutes, and/or total of 1 hour or more, during Friday and Saturday

Source: **Morris et al (1973)** Table 1 p 334

Morris also “postulated”, and he admitted “arbitrarily”, that to qualify as a ‘vigorous’ event the activity also had to continue in duration... “uninterrupted for more than 15 minutes – anything less of these activities, we reasoned, could scarcely include sufficient stress to extend the circulation.” **(op cit p 334)**

By contrast to this threshold or training effect (a combination of specific intensity and duration), Morris and his colleagues could find no evidence “of apparent benefit with increasing activity”, by which he meant just the accumulation of more total volume (kcal) of energy expenditure **(op cit p 338)** and they said so, emphatically:

“In men recording vigorous exercise, the relative risk of developing coronary [heart] disease was about a third that of comparable men who did not, and in men reporting much of it [vigorous exercise] still less. Lighter exercise and provisional estimates of overall activity, showed no such advantage”. **(op cit p 333)**

5.1.3 The Whitehall Study: Its Impact on Subsequent Physical Activity Guidelines

Systematic and scientific study of leisure time physical activity (LTPA), as first elucidated by Morris and colleagues, marked an important shift in 20th century medical and public health thinking. Focus on LTPA, and population free choices, would contribute, as previously argued, to the development of expert physical activity guidelines that were first emerging in the 1970s, and would culminate in the *US Surgeon General's Report on Physical Activity and Health* published on the eve of the Atlanta Olympic Games in 1996.

Previously, all major investigations in the post World War II era into physical activity and health had focused on occupational energy expenditure and its impact on coronary heart disease. This expenditure was neither voluntary nor tailored to meet individual or public health goals. Nor did these large occupational studies explore the energy expenditure and health needs of people excluded from them, namely women, ethnic minorities, children and the elderly. By contrast, Morris' study of LTPA explicitly sought to discover how individuals within a population were choosing, usually without expert advice, to be physically active outside of their duties in the work place. He and his colleagues foresaw that these choices might be guided by the expert advice of exercise physiologists and

other health professionals, not only to achieve 'fitness', but also to promote health and risk reduction from chronic, preventable diseases. They observed:

"In a society that requires diminishing exertion, physical fitness has to be reassessed in terms of cardiovascular health and not the oxygen demands of heavy work.....For a change, we can consider the possible contribution of easy, natural, and, surely, in one form or another, enjoyable habits to the 'wisdom of the body' and the epidemiology of health in middle and old age."

(op cit p 339)

5.1.3.1 Dose-Response: Stricter Measurement

The British investigators, furthermore, were early to refine their methods of activity measurement in search of what would later be called 'dose-response relationships' – a task which would remain central in the evolution of public health guidelines. They stated: "The study hinges on the definition of vigorous exercise, and this needs to be far stricter."

(op cit p 337).

5.1.3.2 The 'Brisk Walk': Vigorous or Moderate, Threshold or Volume?

Perhaps the most important element from a public health perspective of Morris et al 1973 was its search precisely to define a leisure activity which was 'easy, natural...and enjoyable' and yet would still achieve a minimum threshold or training effect to protect heart health. Thus Morris and colleagues proposed 'brisk walking' in their categories **(Table 5.1)** of vigorous activities logged by their civil servant subjects.

As proponents of the 'vigorous alternative hypothesis', Morris and colleagues took care to define ways of walking that could be classed as vigorous. Their basic definition of 'brisk walking' was precisely defined as "over 4 m.p.h. (6 ½ km.p.h.)" **(op cit p 334)**

This seems a classification at odds with their own observation, made just paragraphs before, when elucidating their vigorous hypothesis that: "Repeated regularly enough, 100 kcal spent in running for ten minutes will have quite different consequences....from the same energy expenditure during twenty minutes' walking or a couple hours' sitting." **(op cit p 334)** Having been so comparatively dismissive about the heart health benefits of walking, classifying its virtues with the sloth of sitting, Morris and colleagues nevertheless chose to categorised brisk walking as vigorous activity by increasing its speed (> 4 mph) to

yield their required threshold ‘peaks of energy output of 7.5 kcal or more per minute’ – equivalent to occupational heavy work.

This definition deserves careful examination since the ‘brisk walk’ would, over the next quarter century, gradually become the bench mark of ‘moderate’ activity chosen by later investigators (most notably Blair and Pate) who would subsequently and successfully advocate a shift to less strenuous, more moderate intensity activity as the first and primary message of modern physical activity guidelines. It should be pointed out, however, that future American investigators (**Table 5.2**) frequently failed to state the precise speed of their ‘brisk walks’, or when they did, these speeds ranged typically from 3-4 mph (4.8 – 6.4 km/h) – but never ‘over 4 mph (6 ½ km/h)’ as stipulated by Morris.

Table 5.2
Recommended ‘Brisk Walking’ Speeds for Public Health Purposes (1973-2005)

Speed	Source
>4 mph/6.5 km/h	Morris et al (1973)
4 mph/6.4 km/h	Duncan et al (1991)*
3-4 mph “2 mile walk in 30-40 mins”	Blair et al (1992)**
>4 mph/6.5 km/h	Morris JN (1992)
3-4 mph/4.8-6.4 km/h	Pate et al (1995) p 402***
4 mph/6.4 km/h	Pate et al (1995) p 404***
4 mph (4 METs)	USSG (1996) p 32
3.0-3.9 mph/4.8-6.2 km/h	Manson et al (1999)****
3-4 mph/4.8-6.4 km/h	Brooks et al (2004) *****
4 mph “15 minutes/mile”	US Dietary Guidelines 2005*****

*Cooper Institute, Dallas, Texas

**Co-authored by Paffenbarger

***US Centers for Disease Control/American College of Sports Medicine joint recommendation

****Team led by WC Willett at Harvard University School of Public Health

*****US Institute of Medicine

*****US Department of Agriculture

Source: Table compiled by **JE**

Morris and colleagues’ choice of a minimum speed, and therefore intensity, of over 4mph (6.5 km p/h) was also high by common physiological measures of walking. The standard

reference (**Ainsworth et al 1993 and 2000**) lists many slower speeds of walking (**op cit 2000 p S514**) and requires the high speed of 4.5 mph on a firm flat surface (described as 'very, very brisk') to reach the vigorous threshold (≥ 7.5 kcal/ min = MET ≥ 6) stipulated by Morris and colleagues. Note also that the MET score of 4 mph was raised from 4 to 5 in the standard reference between 1993 and 2000. The US Surgeon General's report (**USSG 1996**) would, obviously, have relied upon the 1993 edition.

5.1.3.3 Self Reporting, Treadmill Tests and 'Relative' Fitness

Morris and colleagues went on to introduce concerns that their respondents, and particularly the older and less fit ones, may have, in their self-reporting, exaggerated the vigour (threshold intensity) of their physical activities. They observed:

"How often the men in their sixties – or for that matter forties – actually reached peaks of 7.5 kcal per minute on these self-regulating activities we do not know; direct measurements of such men obviously will have to be made." (**Morris et al 1973 p 337**)

The accuracy of self-reporting would continue to be a prime focus of public health debate in the evolution of subsequent physical activity guidelines.

Morris and colleagues also flagged the importance of another, closely related issue: relative (and perceived) intensity of physical activity and its appropriate measurement in public health terms: "Since the maximum aerobic output, cardiac output, and heart-rate all decline with age, a sliding scale of effective exercise – lighter for men in their sixties than in their forties – must surely be postulated." (**Morris et al 1973 p 337**) This concern about age (and subsequently, gender, fitness levels, ethnic differences, and genetic predisposition) would also occupy the minds of future public health investigators as physical activity guidelines evolved. (**Bouchard C 1995, Bouchard C and Rankinen, T 2001**)

5.1.3.4 Randomised Trials

Finally, in their pursuit of greater rigour and accuracy Morris and colleagues called for randomised controlled intervention trials to investigate with greater precision the impact of physical activity 'doses' upon physiological and psychological health outcomes:

“In the long run, we must aim to define high-intensity exercise by demonstrable objective and subjective, immediate as well as long-term effects....At the least, randomised trials could be mounted of manageable samples of inactive men persuaded to engage in a programme of progressively vigorous exercise.....The whole field wants developing - quite regardless of our findings.” **(Morris et al 1973 p 338).**

5.1.4 Summary of Morris et al 1973

The study by Morris and colleagues therefore represented an advance in standards for the investigation of the impact of physical activity upon health, in at least six distinct ways:

1. It improved accuracy in estimating leisure time physical activity by recall questionnaire.
2. It recognised the limitations of self-reporting and problems of defining and measuring ‘relative fitness’ in different populations.
3. It adopted a definition and threshold (≥ 7.5 kcal/min EE or ≥ 6 METs) of ‘vigorous’ activity.
4. It adopted a definition of its ‘minimum duration’ (15 minutes).
5. It adopted a definition of a ‘brisk walking’ speed (vigorous intensity at >4 mph >6.5 kmph).
6. It reported a strong inverse association found between vigorous LTPA and CHD.

In summary, therefore, the findings in **Morris et al 1973** appeared to have offered numerous crucial insights that subsequently influenced the course of most future investigations in the study of physical activity and health outcomes.

5.2 Paffenbarger et al 1978: *The Harvard Alumni Study: The Threshold Intensity v Total Volume of Expenditure Debate: 1978-1980*

While Morris in Britain continued to focus on a perceived ‘threshold’ of vigorous physical activity intensity to protect against heart disease, Paffenbarger and his colleagues in the United States chose in their investigations of LTPA to explore both the intensity and total

weekly volume in kcals of energy expended. Their different approaches would play a central role in shaping the public health guideline debate on physical activity.

Ralph Paffenbarger had already studied 'college case-taking records' to determine the predictive undergraduate baseline impact of sports activity and seven risk factors (including smoking, high blood pressure, and excess body weight) on the heart attack death rates in later life of American college students. **(Paffenbarger et al 1966)** In the wake of Morris' longitudinal work in Britain, Paffenbarger, professor of epidemiology at the Stanford University School of Medicine, published in 1978 the first results on the adult leisure-time physical activity (LTPA) patterns of nearly 17,000 male alumni of Harvard University in Cambridge, Massachusetts. If Morris' cohort of male civil servants did not reflect a representative sample of the entire British population, such criticism must apply even more to Paffenbarger for choosing an all male cohort taken entirely from the most elite and exclusive university in the United States. Indeed, Paffenbarger and colleagues later acknowledged just how atypical the Harvard cohort was (by public health measurements) when compared to other white American males. **(Paffenbarger et al 1986 p 612)** But, like Morris and his team, they were drawn foremost by the likelihood that their cohorts were unusually homogeneous (thus reducing confounding variables) and were unusually likely to respond, when requested, to the self-reported questionnaires. **(personal communication with JN Morris, London April 2004 and RS Paffenbarger, Berkeley, California August 2002)**

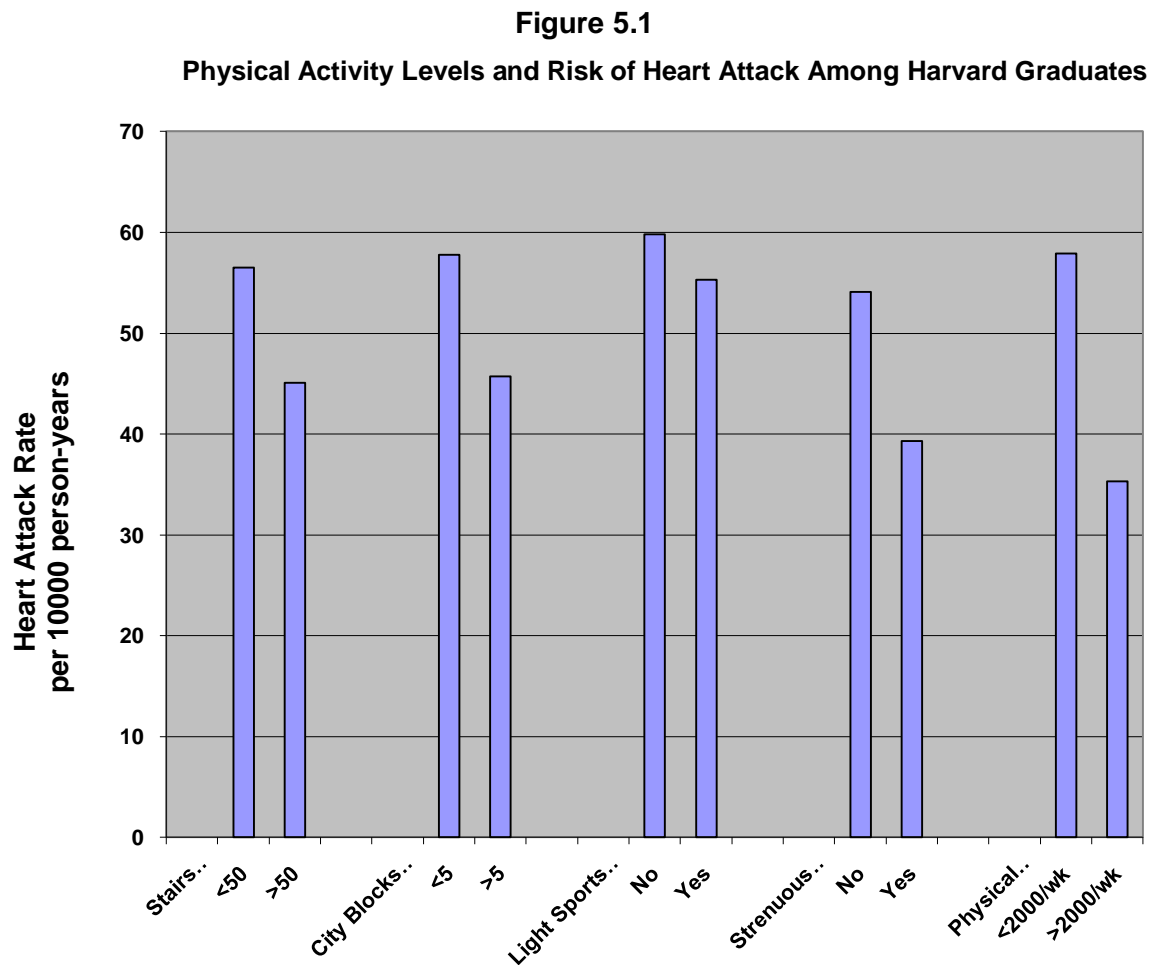
The Harvard alumni graduated between 1916 and 1950 and they responded to questionnaires in a 6 to 10 year follow up between 1962-1966-1972. Unlike Morris, who had access only to the adult questionnaires, Paffenbarger could rely also on the university's archives for "authentic data on student athleticism and personal background." **(Paffenbarger et al 1978 p 162)**. Hence, he could also explore whether this youthful fitness from sport would have an independent 'protective' effect on the men's heart health in later life and concluded from this 'cross-tabulation' that: "Student athleticism *per se* is unrelated to heart attack risk in later life". **(op cit p 170)**.

5.2.1 The Physical Activity Index and 'volume cutpoint'.

Next, and crucially for the purposes of this dissertation, Paffenbarger and his colleagues used the adult questionnaires to construct a 'physical activity index' which included

questions about 'vigorous or strenuous sports play', light less structured sports play, and daily unstructured, moderate activities: stairs climbed and city blocks walked. In one graphic illustration, therefore, Paffenbarger and colleagues wanted to see if sheer volume of LTPA in kcal/wk, and/or the threshold intensity of vigorous activity had a protective effect in reducing heart attack risk in later life.

As can be seen in **Figure 5.1** all reported LTPA (both vigorous and non-vigorous) was aggregated to establish an energy expenditure 'cutpoint' of fewer than 2,000 kcal/wk or more than 2,000 kcal/wk.



Source: **Paffenbarger et al (1978)** Table 1 p 165. Some 16,936 Harvard male alumni aged 35-74, reported free from heart disease in 1962 or 1966 and followed up in 1972. Data are age adjusted. Risk ratios (rate of less active divided by more active) and p for trend by activity: stairs <50/>50 1.25, $p=.008$; city blocks <5/>5 1.26, $p=.016$; light sports no/yes 1.08 $p=.501$; strenuous sports no/yes 1.38 $p=.001$; PA index <2000kcal/>2000kcal 1.64 $p<.001$

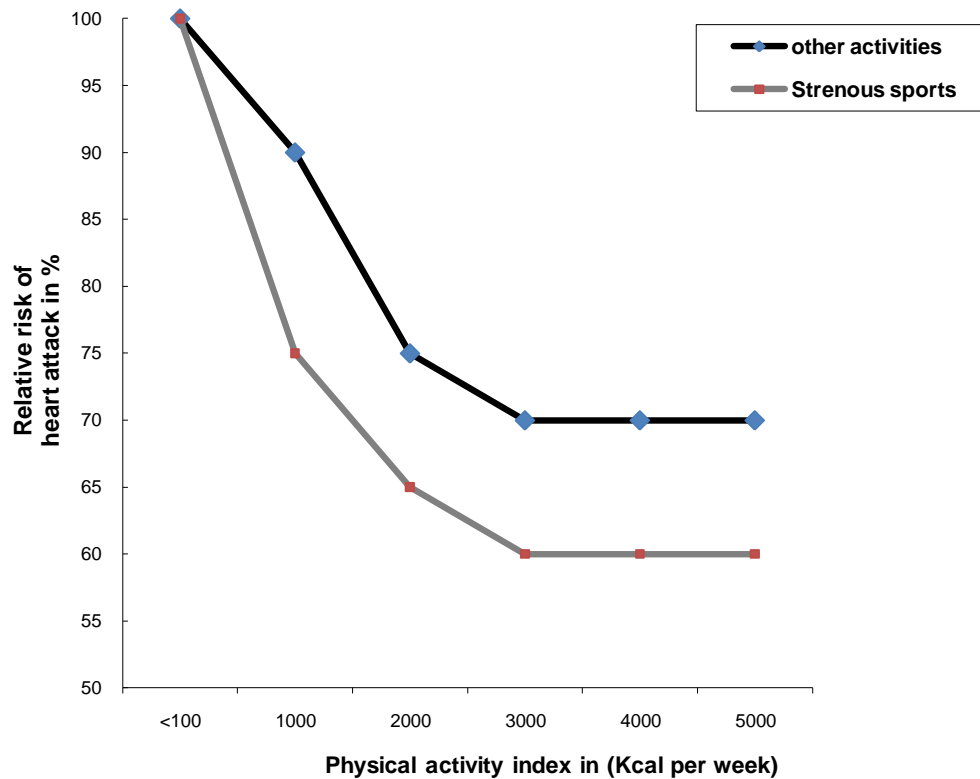
The results showed that, as an indicator of comparison, the greatest risk reduction of heart attack rate came at the total volume cutpoint of 2,000 kcal/wk. Those alumni who exceeded that volume had a relative risk reduction of 1.64 compared to those under the total volume cutpoint (1.0 referent). By contrast, those who answered 'yes' to weekly strenuous sports play had a smaller risk reduction (1.38) compared with those who said 'no'. However, those who said 'yes' to ≥ 3 hrs/wk of strenuous sports play had a relative risk reduction of 1.54 compared to those who reported ≤ 3 hrs/wk. **(Paffenbarger et al 1978 p 165)**

So the question arose: Was total volume of energy expenditure alone the best predictor and provider of heart attack rate reduction? Or, did strenuous or vigorous activity also play an important role? On the one hand, volume appeared best (1.64). But ≥ 3 hrs/wk of strenuous sports compared with <3 hrs/wk showed a risk reduction (1.54) nearly as high. Was this an expression of the 'threshold' effect of vigorous exercise first described by Morris?

The answer remained complex. What proportion of the total volume of energy expenditure reported by each alumnus was actually contributed, at a rapid rate, by strenuous exercise, and did this proportion affect relative risk of heart attack? Paffenbarger and colleagues attempted **(Figure 5.2)** to answer that crucial question by stripping out 'strenuous sports' from 'other activities' at increasing volumes of energy expenditure.

Figure 5.2

The Benefits of Strenuous Sports in the Protection from First Heart Attack Among Harvard Graduates



Source: **Paffenbarger et al (1978)** Figure 5 p 171. Relative risk of first heart attacks measured by “physical activity index” of total kcal of energy expenditure per week in stairs climbed, city blocks walked, light sports played and strenuous sports played. Each curve is adjusted for differences in age, period follow up and level of energy from the other type of activity. Strenuous sports $p=.005$, other activities $p=.011$

At lower total volumes (<1,000 kcals/wk) the impact of strenuous sports in reducing relative risk appeared to be greater. At >2,000 kcals/wk its comparative impact was smaller, but still significant, and the authors concluded:

“Thus at any given level of energy expenditure, the risk of heart attack tends to be lower with strenuous sports than with more casual activities.” (**Paffenbarger et al 1978 p 171**). They further concluded: “The persistent corroborations encountered in these data strongly support a protective role for vigorous exercise in the reduction of heart attack risk.” (**op cit p 173**) And they further, and most succinctly, summarised their findings as: “Adult exercise was independent of other influences on heart attack risk, and peak exertion as strenuous sports play enhanced the effect of total energy expenditure.” (**op cit p 161 abstract**)

While the superior benefits of vigorous or strenuous intensity energy expenditure were evident among the Harvard men, the data, as represented, did not replicate the ‘threshold’ effect observed by Morris and his colleagues: that only activities above a minimum intensity (7.5 kcal/min) provided protection. On the contrary, ‘other’ non-strenuous activities also offered significant, if less great, protection, in a similar curvilinear way up to an asymptote of approximately 3,000 kcals/wk.

In their final words Paffenbarger and colleagues failed to address, or at best, side-stepped the ‘vigorous v moderate’ debate, with a swing back to a simple physical activity ‘sound bite’: “Risk of heart attack is increased if physical activity is reduced below favourable levels, and risk is lowered if adequate exercise is maintained.” (**op cit p 174**).

But was ‘adequate’ defined by volume, intensity....or both? Debate over the definition of ‘adequate’ physical activity would continue up until, and beyond publication of the US Surgeon General’s Report (USSG 96).

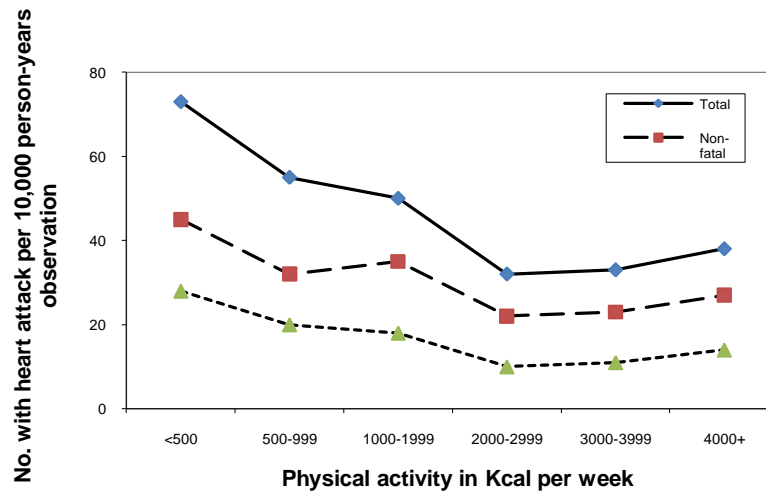
5.2.2 Summary of Paffenbarger et al 1978

The conclusions of Paffenbarger's study appear not to have supported Morris' theory that vigorous activity did play a unique role characterised by a 'threshold' effect in reducing heart attack risk, but only after a minimum intensity (7.5 kcal/min) was achieved at a minimum duration (≥ 15 min). But the concept of a 'threshold' or training effect, unique to vigorous activities conducted above a defined level of intensity, was not directly reported or discussed by Paffenbarger and his colleagues in the paper. Instead, the study was, or could have been interpreted as, also supporting the concept that moderate intensity LTPA, at or above an 'adequate' volume could reduce heart attack risk, albeit less so, if no vigorous activity was included in the weekly total. As such, the study's findings would become an early and often cited benchmark used to support a new public health guideline which would largely remove prominence from vigorous activity, and recommend instead moderate amounts of moderate LTPA as a baseline to achieve significant, if not ideal, reduction in heart attack risk.

Finally, the study also raised another very interesting issue, not previously identified or discussed (**Figure 5.3**). Increasing energy expenditure above 2,000 kcal/wk only reduced relative risk by a much more modest amount than by achieving the 2,000 kcal/wk 'cutpoint'. And energy expenditure above 3,000 kcal at any intensity, either had no further evident effect on risk reduction or might actually cause risk to rise.

Figure 5.3

Relationship Between Weekly Physical Activity Levels and Rates of First Heart Attacks Among Harvard Graduates



Source: **Paffenbarger et al (1978)** Fig 1 p 166. Age adjusted first heart attack rates (fatal and non-fatal) measured by “physical activity index” of total kcal of energy expenditure a week in stairs climbed, city blocks walked, light sports played and strenuous sports played.

This last conclusion, that risk reduction appeared to be somewhat concave curvilinear with an unproductive, and possibly dangerous asymptotic tail (regardless of intensity) beyond a further cut-off point ($>3,000$ kcals/wk), was to resemble, and would be supported by, the conclusions of a paper by Blair in 1989 (**Blair et al 1989**) that would, it is argued, be seminal in the construction of the *US Surgeon General's 1996 Report* (and guideline recommendation) on *Physical Activity and Health*.

5.3 Morris et al 1980: Benefits of Vigorous Activity Asserted Again

In a second and longer follow up (8½ years) to 'The Whitehall Study', Morris and colleagues further explored their primary finding that physical activity must be vigorous to provide significant protection against coronary heart disease. They concluded that:

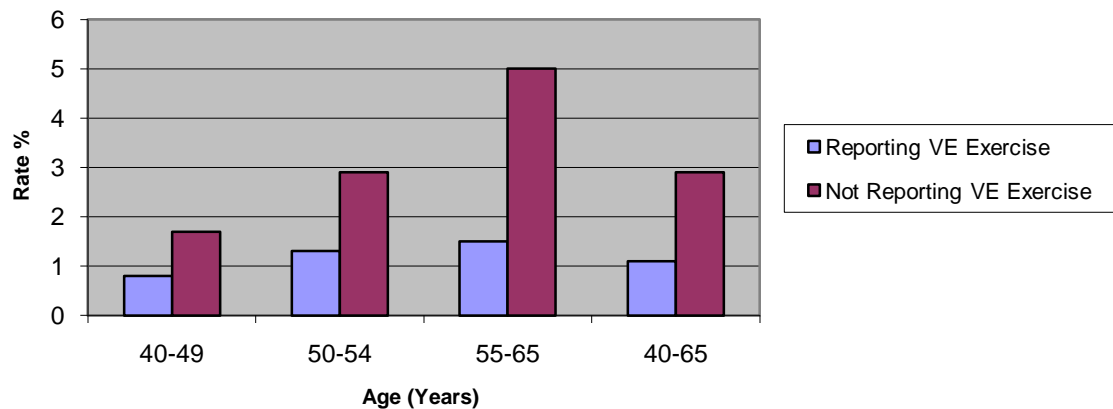
“For men engaging in VE [vigorous exercise] sports during the two sample days the risk of fatal heart-attack was about 40% of that of their colleagues reporting no vigorous exercise.” **(Morris et al 1980 p 1209-10)** However, they acknowledged, apparently for the first time, “...a weak association between estimates of total physical activity...and the subsequent incidence of CHD: men in the upper third of the distribution of energy expenditure had somewhat lower coronary rates than the rest.” **(op cit p 1207)** However, they emphasised that high totals of moderate intensity activity were relatively unimportant in reducing heart disease risk among their British cohort of lower middle class civil servants and continued:

“There was a much stronger association, however, between the incidence of CHD and the report of vigorous exercise in leisure-time (VE), the most strenuous activities undertaken by these men and defined as those likely to reach peaks of energy expenditure of 7.5 kcals/min, a threshold equivalent to heavy industrial work.” **(op cit p 1207)**

Later, the authors emphasised their conclusions from the data once more
(Figure 5.4)

Figure 5.4

Vigorous Exercise (VE) and Incidents of Fatal Heart Attacks in Male Executive Grade Civil Servants



Source: Data assembled from **Morris et al 1980** Table 1 p 1208

They stated that:

“Physiologically, the indication that high totals of physical activity are of some benefit, but far less than another aspect of high energy output – namely, the intermittent peaks of high intensity – points to training, physical fitness, central and peripheral cardiovascular efficiency, perhaps coronary flow.” **(op cit p 1210)**

5.3.1 ‘Adequate’ Exercise Re-defined

The parallel work of the American team led by Paffenbarger (**Paffenbarger et al 1978**) was cited by the authors in their references, but not commented upon directly. However, the British investigators appear to have taken issue with the Americans’ final conclusion that heart attack risk is lowered if ‘adequate’ exercise is maintained. As previously discussed, to Paffenbarger and colleagues ‘adequate’ exercise appeared, primarily at least, to mean total accumulated volume of weekly energy expenditure of $\geq 2,000$ kcal with or without inclusion of any vigorous activity. But to Morris and his team ‘adequate’ meant something entirely different: intensity, not volume alone. They observed:

“‘Adequate’ exercise means vigorous exercise....above the intensity required for a training effect.” **(Morris et al 1980 p 1210).**

Morris and colleagues also examined whether reported vigorous intensity activity had any ‘protective effect’ against common risk factors for CHD and CHD death – including family history of the disease, cigarette smoking, hypertension, type 2 diabetes and unhealthy weight (BMI >25). While thin data (‘small numbers’) in some risk categories hindered analysis, in each category the trend was favourable, and in “family history” and “cigarette smoking” it was highly significant. **(op cit pp 1208-09)**

Next, Morris and colleagues offered a simple prescription – vigorous exercise and tobacco smoking cessation, as a rapid cure to the ‘coronary epidemic’ then sweeping the Western world:

“Together the two behaviours studied make an encouraging picture: the cohort of 1400 office workers aged 40-65 at entry who engaged in VE sports and did not smoke registered 12 fatal first ‘coronaries’ in 12,000 man-years of observation – scarcely an ‘epidemic’, and about one-fifth of the rate of their colleagues who recorded no vigorous exercise and did smoke cigarettes.” **(op cit p 1210)**

5.4 Summary: The Threshold v Total Volume Debate: 1978-1980

While Morris and colleagues stuck to their conclusion that only vigorous exercise, at a threshold sufficient to impose a ‘training effect’ on the heart, could substantially reduce heart disease and heart attack fatalities, their interpretation of vigorous and ‘non-vigorous’ activities may need further examination. First, they appeared in their conclusion to suggest that their definition of vigorous exercise was neither extreme, nor unpleasant when performed in leisure time by middle aged British office workers:

“In the nature of it, although ‘vigorous’, the self-chosen, self-regulated, and presumably enjoyable activities that make up VE sports are by no means extreme – our men are no athletes. Indeed, the remarkable ordinariness in so many respects of the VE men is further encouragement.” **(op cit p 1210)**

Second, as previously discussed, Morris and colleagues needed to push the concept of a 'brisk walk' to its energetic limits (>4 mph/6.4 kmh, ≥ 7.5 kcal/min, $\geq 6+$ METs) to boost it, just, past their threshold of vigorous intensity activity.

Third, as we have seen, when Morris and colleagues did examine their data without reference to threshold intensity, they did observe that the men in the upper tertile of total volume of energy expenditure exhibited "somewhat lower coronary rates than the rest." **(op cit p 1207)** Measured in this way, moderately intense activities would thus appear to have some, albeit more modest, protective effect.

Yet, in their primary flow of argument in favour of vigorous exercise, this distinction passed unmentioned when Morris and colleagues reported that the fatal heart attack rate of vigorous exercisers "was about 40% of that of their colleagues reporting no vigorous exercise." **(op cit 1209-10)** However, by this method they appeared, in effect, to lump all 'non-vigorous' men together – and hence to corral statistically the moderately intense exercisers with their sedentary colleagues, and, arguably, thereby possibly obscure, diminish, or at least fail to highlight any heart benefits that moderate leisure time physical activities might have.

5.4.1 Design Differences

Can study design differences alone explain why the American team identified clear cardiac benefits from total volumes of physical activity, while the British investigators, focusing on a minimum threshold of intensity, believed that the volume of expenditure, or non-vigorous activity was at best, weakly significant? It should be borne in mind that the volume 'cutpoint' chosen by Paffenbarger was 2,000 kcal/wk. While the 'basket' of his counted activities did also include stair climbing and moderately paced (city block) walking – as well as deliberate sports play – 2,000 kcal/wk was, nonetheless, twice the total volume in kcals of deliberate exercise energy expenditure recommended in public health physical activity guidelines (1,000 kcals/wk) then (1978-80), and in the 1996 US Surgeon General's report in 1996, and which was still the guideline recommendation until October 2008. **(NB 5 brisk 30 minute walks, or 3 vigorous 20 minute bouts of exercise both theoretically yield energy expenditure of approximately 1,000 kcals/wk).** (See USDHSS 2008 and USDHSS AC 2008 in 'postscript' in Chapter 12)

It would therefore seem unlikely that casual stair climbing and moderate walking would have amassed 1,000 recorded kcal/wk, suggesting that the more active alumni ($\geq 2,000$ kcal/wk) may well have been doing more deliberate, and most probably, more vigorous exercise than was specifically evaluated in Paffenbarger's investigation.

5.4.2 Cohort Differences

Morris and colleagues described their 'Whitehall' civil servants as 'executive grade' white, middle class office workers. While accurate, this description may have been unintentionally misleading -- especially in comparison to the far more affluent and overwhelmingly better educated Harvard alumni. First, 'executive grade' was actually a flattering term for a rather modest group of civil servants who were not in the top flight advising ministers or helping to shape government policy. To the contrary, Morris later typified his office worker cohort as modestly paid "lower middle class tax collectors". And, not a single one of the near 18,000 men had a university degree (**personal communication with JN Morris, London April 2004**), unlike Paffenbarger's men, 100% of whom had at least a bachelor's degree from the most celebrated university in the United States (Harvard Alumni).

Arguably, therefore, the British civil servants, with less income, fewer motor cars and lifts, and more walks to the bus stop might -- unstructured, unobserved and unrecorded -- have done more moderate intensity activity, and at longer duration than their Harvard counterparts. Out of necessity, therefore, they may well have been substantially fitter than the Harvard cohort, especially at a time when home exercise equipment and/or gym membership were not yet *de rigour* for men of Ivy League status.

Indeed, Morris subsequently concluded that the single biggest factor which distinguished the British cohort from the Americans was the Britons' avid commitment to, and therefore their high frequency of, arduous gardening. Even though this 'heavy' leisure time physical activity was not statistically and directly significant by itself in relation to heart attacks, it nevertheless must have made the British cohort fitter -- thus making the impact of moderate activities less visible upon them. (**personal communication with JN Morris, London December 2006**)

In conclusion, whatever the differences which may have separated and distinguished Morris and Paffenbarger, in tandem their work moved investigation of physical activity and health away from the occupational workplace and into the more complex and diverse realms of leisure time physical activity (LTPA). From a public health perspective, these investigations (**Morris et al 1973, Paffenbarger et al 1978 and Morris et al 1980**) while still focused on white, middle and upper-middle class male cohorts, nevertheless paved the way for a small group of 'enthusiasts' at the US Centers of Disease Control and Prevention (CDC) to begin to make their 'science policy' case for promotion of LTPA as a primary health promotion tool for all members of the American public – regardless of gender, class or ethnic group. Their case was further advanced, not only by Paffenbarger's early examination of the benefits of moderate intensity activities (rapidly perceived as more 'palatable' to an increasingly sedentary nation) but also by Paffenbarger's subsequent willingness to join and advance the public health policy debate, while continuing his epidemiologic investigations at Stanford. It is to the early work in the 1980s of this small group of people at the CDC, who were eager to accumulate and articulate the case for physical activity as a public health too, that the discussion now turns.

Chapter 6: Scientific Study of Physical Activity Takes Its Place in the Public Health Movement

6 Introduction

This chapter first explores the creation of the first 'physical activity and health unit' by Kenneth Powell at the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia and the subsequent workshop that he and Ralph Paffenbarger convened in 1984 which laid the first important public health foundations for the *US Surgeon General's Report on Physical Activity and Health* 12 years later. Secondly, we see how, in two separate reviews of the emerging literature, Powell tried to assess how far the association between physical activity and heart disease protection had been established by the late 1980s.

When the US public health movement began in the post World War II period to focus on cardiovascular disease (**Beaglehole et al 1993 pp 140-143**) and other chronic conditions, the scientific study of physical activity appears to have remained largely in its academic and cultural backwater of exercise science, useful for training elite sportsmen, but otherwise relegated to school playing fields where children were instructed, sometimes reluctantly, in physical education.

There was some emerging concern about the lack of physical fitness among American school children which led to the creation of the President's Council on Physical Fitness (and Sport) in 1956 and its first (and largely ignored) guidelines in 1965, and then to a review by Pollock (**Pollock ML 1973**) which indicated that the focus of the discipline still remained on physical training to improve aerobic power and body composition – upon exercise fitness, as opposed to wider health outcomes. (**USSG 1996 p 41**).

It took the pioneering work of Morris, and Paffenbarger to begin to convince health professionals and the lay public of the significant role of physical activity in preventing and reducing death rates from heart disease. The American Heart Association did produce its first tentative guidelines in 1972, but it would, after Morris' and Paffenbargers' leisure time studies (LTPA) in 1973 and 1978, begin to make physical activity less peripheral to its public health agenda.

6.1 The CDC Physical Activity Workshop: 1984-1985: Research Interest Widens to Include Other Health Outcomes

An early and important development came in 1983 when the US Government's Centers for Disease Control and Prevention (CDC) in Atlanta created a Behavioral Epidemiology and Evaluation Branch (BEEB). The major responsibility of the BEEB was the 'epidemiologic study' of physical activity. **(Powell and Paffenbarger 1985 p 118)**. Dr Kenneth Powell, a physician whose primary interests and experience were in public health, was its first director. Powell's first step was to hire Carl Caspersen, an exercise physiologist who, unusually, was much more interested in public health than in understanding elite athletic performance. His second important step was to enlist the support of Ralph Paffenbarger who he had previously met at an academic conference. Meanwhile, Caspersen was to seek out the assistance of Steven Blair, an investigator with a doctorate in physical education, who worked at the Cooper Institute in Dallas, Texas. **(personal communication with SN Blair, London September 2006 and with KE Powell, Atlanta, Georgia May 2007)**. Between them, they forged the first *Workshop on Epidemiologic and Public Health Aspects of Physical Activity and Exercise* which was convened in 1984. It brought together a chosen group of America's relatively few doctors and scientists who had decided to investigate the impact of physical activity on health. When summarising the findings and impact of the workshop, Powell and his co-author Paffenbarger captured the growing importance of their fledgling field with these opening remarks of their lead paper which was published the following year:

"In 1975, MILTON TERRIS observed that 'physical fitness and physical education have no respected place in the American public health movement'. Less than 10 years later, however, the situation has changed markedly. In response to the growing body of evidence that regular physical activity produces substantial physical and emotional benefits, the Public Health Service specified 'Physical Fitness and Exercise' as 1 of the 15 areas of greatest importance for improving the health of the public." **(Powell and Paffenbarger 1985, p 118)**

In making this observation Terris, a physician, epidemiologist and chairman of the Department of Community and Preventive Medicine at New York Medical College, was

critical, not of the study and practice of physical fitness and education, but of the narrow vision of the American public health movement of the time. He observed that:

“Their practitioners [physical activity investigators] have been labeled by at least one elder statesman of public health as ‘the big-muscle boys’ and this contemptuous attitude has persisted to this day....On the subject of physical fitness I speak with no authority. Having spent a large portion of my life seated at a desk, I have no personal acquaintance of the concept. On a more intellectual level, I have been far too bound by the philosophical rigidities of the American public health movement to become knowledgeable in the literature of this field...”**(Terris M 1975 p 1040).**

6.1.1 Methodological Weaknesses and Knowledge Gaps Examined

While they were pleased that the academic rigour and public health value of their discipline was finally being recognised, Powell and Paffenbarger nonetheless identified key weaknesses in the discipline’s scientific development that have continued to hamper its influence in public health throughout the 1980s the 1990s and into the 21st century. These weaknesses identified by Powell and Paffenbarger are examined here.

6.1.1.1 Loose measurement terms

Foremost was the recognition that physical activity and fitness, while sometimes dismissed by more influential medical disciplines, was nonetheless “a complex behavior that is difficult to measure, and the accuracy of most measurement instruments is not known.” **(Powell and Paffenbarger 1985 p 118).** At this inaugural work shop, and at others to follow, investigators would lament the lack of scientific precision with which physical activity was systematically described, defined and empirically measured. For example, in Blair’s review, given at the workshop with Powell, on the relationships between exercise or physical activity and other ‘health behaviours’ he and colleagues observed:

“Several problems are encountered in reviewing research on exercise and physical activity. First there are no consistent definitions of these terms used by different authors. Also, assessments of exercise and physical activity have been crude and imprecise.” **(Blair et al 1985 pp 172-73)**

The most common terms of measurement were, and remain: mode (or type of physical activity), intensity, frequency, duration and adherence (to a defined programme or regime of exercise). In addition, other, more ill defined descriptors would find their way into studies, making them even more difficult to compare – most notably the terms: ‘level’ ‘total of’, ‘amount’ of, ‘adequate’ and ‘volume’ of activity. Thus the description ‘moderate physical activity’ lacks precision in several ways: There is no agreed and clear definition of moderate on a continuum ranging from sedentary inactivity, light activity through to very vigorous activity. ‘Total of’, ‘amount’, and ‘level’ are equally ill defined. Thus moderate physical activity, might in some investigations mean a moderate amount (total volume measured in total kcals of energy expended). In other circumstances it might loosely be used to measure the intensity of activity, while intensity can itself be quantified in at least four distinct ways:

1. kcals expended per minute (kcals/min)
2. METs (metabolic equivalents of tasks)
3. percentage of maximum oxygen uptake ($\text{VO}_2 \text{ max}$)
4. percentage of maximal heart rate

6.1.1.2 Study Design:

Powell and Paffenbarger also regretted the (over)reliance on cross-sectional epidemiological studies which were not performed at regular intervals or over a sufficient length of time (longitudinal) to reveal any secular trends in physical activity. Experimental (randomised) studies, “the purest design”, were too seldom done because “often they may be unfeasible, impractical, or unethical.” **(Powell and Paffenbarger 1985 p 123)**

6.1.1.3 Dose-Response: Threshold Effect v ‘Moderate’ Activity and Greater Adherence

The same authors expressed the almost universal concern among the workshop delegates that too little attention was being given to measuring with precision the impact of defined doses of physical activity (mode, intensity, duration, frequency and adherence) upon precisely defined health outcomes (disease/condition response). They did, however, reject a search for a minimum intensity ‘threshold effect’ (as described by Morris) and appeared to put their weight behind further examination of the health benefits of light and moderate activity, given their assumption, without supporting evidence, that these less strenuous activities would attract relatively higher public health benefits and greater adherence than more vigorous ones. The explanation as to why Morris’ ‘threshold

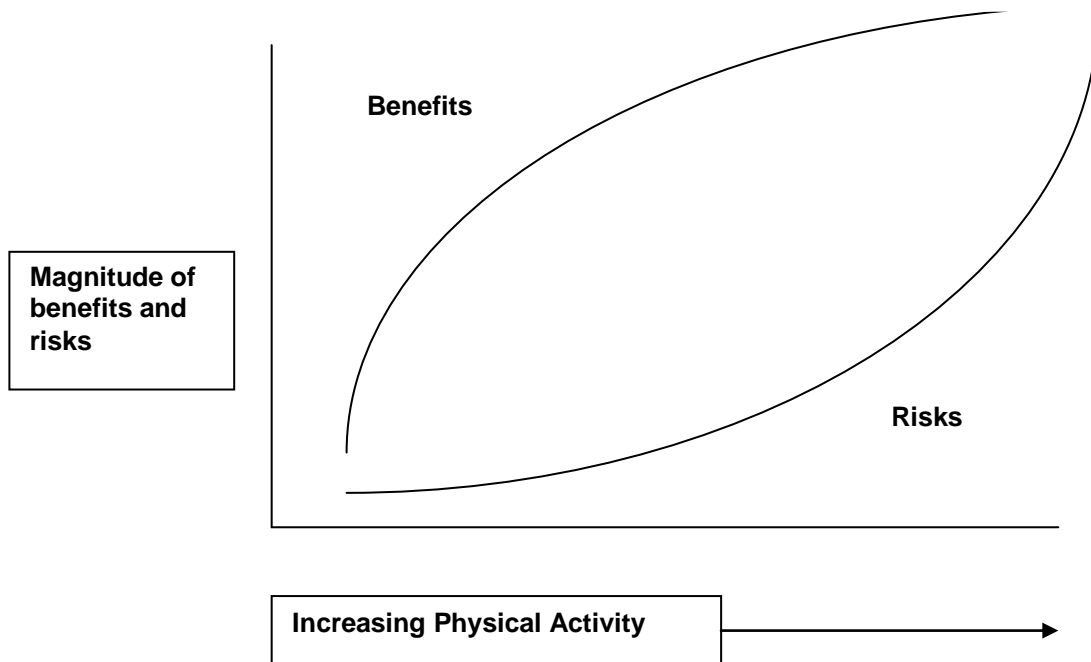
hypothesis' was not seriously explored may have lain in the workshop's collective desire to focus upon and promote the wider 'public health' importance of physical activity and the concomitant belief, without cited evidence, that low to moderate intensity physical activity was both medically desirable and more widely acceptable to a broader number of people – and thus a better 'public health prescription'. **(personal communication with KE Powell, Atlanta, Georgia May 2007)**

This perceived association between non-vigorous activities and population adherence or compliance was repeated and used, in effect, to reject the vigorous threshold hypothesis of Morris: As Powell and Paffenbarger said:

“In almost every paper (of the workshop), the paucity and necessity of dose-response information are mentioned. This should not be mistaken for the search for a single optimal level below which there is no benefit and above which one reaps full reward. On the contrary, the interest in dose-response information stems from the recognition that dose is probably inversely related to likelihood of participation and from the necessity to compare benefits and risks (as described subsequently) both of which are almost certainly dose-related. The increase in benefits may be greatest at low levels and diminish with increasing activity. Risks, on the other hand, may be less at lower levels and become increasingly more frequent and severe at higher levels.” **(Powell and Paffenbarger pp 123-4)**

Once again, this belief in public acceptance of low-risk, high benefit non-vigorous activity was underscored by the authors when they produced a 'theoretical graph' **(Figure 6.1)** to illustrate their argument:

Figure 6.1
Theoretical Relationships of Benefits and Risks with Level of Physical Activity



Source: **Powell and Paffenbarger (1985)** Fig 2 p 123

6.1.1.4 Dominance of White Male Studies: The need to investigate other cohorts

Powell and Paffenbarger expressed further concerns about selective cohorts: “Another frequently mentioned deficiency of currently available data is the lack of information pertaining to specific subgroups within the population such as children and adolescents, elderly, the disabled, and others.” (**op cit p 124**). Among the ‘others’ not specified were women and ethnic minorities within the United States. It will later be seen that this major knowledge gap remained 12 years later, when the US Surgeon General’s report was published.

6.1.2 Walking: The Public Health Prescription is Introduced

Powell and Paffenbarger also introduced the novel suggestion, that “low intensity” walking (distinct and diminished from Morris’ vigorous definition) might well be the best mode of physical activity when presented as a public health guideline prescription:

“The effect of low-intensity activity, such as walking, is of great interest. It appears likely that the greatest gain in the risk-benefit relationship per unit change of physical activity occurs at the lower end of the activity spectrum.”
(op cit p 124)

Their cited reference for this observation was Haskell and colleagues' paper presented at the workshop and examined below.

6.1.3 Summary of Powell and Paffenbarger's Workshop Framing Paper

Whatever its shortcomings, the 1984 CDC workshop organised by Powell was a landmark event in beginning to put the study of physical activity and the promulgation of official population guideline recommendations on the public health agenda in the United States. It was also becoming clear from the papers submitted that the workshop consensus was supportive of the emerging 'moderate activity hypothesis'. This concept would put emphasis upon the relative health benefits of activities of moderate intensity while de-emphasising health benefits for most individuals derived from more vigorous activity and its alleged 'threshold' effect. The workshop consensus favoured instead a public health prescription of 'brisk walking', or similar moderate intensity activities, to which the sedentary population were assumed, most likely to adhere.

This chapter now explores the extent to which this belief in the public health benefits of moderate physical activity was based on robust and reliable science, and/or to what extent, if any, the (moderate) 'physical activity, health improvement hypothesis' was a hybrid, constructed also from social elements which can be disentangled and illuminated.

6.2 The Case for Moderate Activity Guidelines is Proposed and Elucidated:

Haskell et al 1985

Arguments in favour of a moderate activity public health prescription were perhaps most clearly proposed at the workshop and subsequently published by William Haskell and colleagues. **(Haskell et al 1985)**. Their case for what they describe as the (moderate) 'physical activity – health improvement hypothesis' rested on four planks:

1. Many people, especially the sedentary and/or elderly, cannot, will not, or do not want to exercise vigorously (poor adherence).
2. Physical fitness and health improvements are not always synonymous.
3. Most risk reduction from heart disease comes from the 'lower levels' of activity achieved when people move from being sedentary to modestly activity.
4. Very significant health benefits can be achieved from moderate intensity activity.

In their introduction, the authors made clear their belief that vigorous activity or exercise was off-putting to a large proportion of the American population: "Since many people would prefer not to have to exercise vigorously to maintain good health, what is the minimum amount of exercise needed to improve health status?" **(op cit p 203)** However, no evidence or references were offered to support that assertion.

Haskell and colleagues also proposed that the established concept of exercise fitness – usually associated with cardiorespiratory (aerobic) and muscular improvements -- could be distinguished from, and was not always required to achieve, other measurable health outcomes that may be of greater public health importance:

"Becoming more physically fit and improving health status are interrelated, but they are not synonymous. Physical activity may improve physical fitness (or one of its components) and clinical health status at the same time, but the improvement in health may be due to biologic changes different than those responsible for the improvement in physical fitness." **(op cit p 203)**

The distinction between fitness and health was emphasised: "...many biologic and psychologic benefits can occur as a result of exercise or activity regimens that do not increase $\dot{V}O_2$ max [maximum oxygen uptake] or endurance capacity." **(op cit p 205)**

The benefits of 'low intensity' activity were underlined: "...low-intensity dynamic activity (less than 60 percent $\dot{V}O_2$ max) can reduce stress, contribute to weight loss, or improve selected biochemical reactions..." **(op cit p 205)** However, no references were provided. It was also unusual to describe <60% $\dot{V}O_2$ max as 'low intensity', since 60%, or even 50% was, and is normally considered **(USSG 1996 p 39, McArdle et al 1996)** to be the minimum 'cutpoint' for vigorous activity – and thus any concept of moderate, or moderate-to-vigorous activity was lost altogether. Indeed, later in their paper the authors appeared

to concede this point when they were critical of evidence supporting the health benefits of vigorous activity:

“The idea that endurance exercise needed to be performed at 60 percent or greater aerobic capacity for beneficial changes to occur came from a short-term exercise training study on young men.” **(Haskell et al 1985 p 207)**

Haskell and colleagues appeared, however, to dilute their assertion that non-vigorous (low-moderate intensity) activities are very beneficial and closely similar to vigorous activities. “It appears that it may take a longer time for lower intensity exercise to produce results **some-what similar** to those frequently observed with higher intensity aerobic training.” **(op cit p 207) (emphasis added)**

Yet these comparative deficiencies – “some-what similar” and “may take a longer time” - were described not as merely trivial, but as positively advantageous in public health terms because their effect would be to encourage a reluctant, exercise adverse, population to become more active:

“However, this alternative (lower intensity exercise) might be quite desirable if we are advocating a permanent change to a more active lifestyle, since the lower intensity is more acceptable to a larger portion of our target population and the medical risks are substantially less.” **(op cit p 207)**

Once again no evidence or references were provided to back up the assertion that people are more likely to adhere to a low intensity exercise regime where it takes considerably longer to achieve a less satisfactory (beneficial) result.

Finally, Haskell and colleagues made an assertion about the concave curvilinear association between the intensity of exercise and improved health outcomes. This assertion would be repeated by other investigators (most notably Blair) and, would become the cornerstone public health argument for dropping advocacy of vigorous activity guidelines in favour of moderate intensity alternatives: They concluded:

“In most cases, the major differences in the incidence of coronary heart disease are between those people who do almost nothing and those who get some form of exercise (by moving their bodies around) on a regular basis.” **(op cit p 208)**

Again, no evidence or references were presented to defend the assertion that the greatest health benefits are achieved at the lower levels of activity, and with "...much less effect apparent between the moderately active and the very active." (op cit p 209)

Yet, adjacent to this scientific claim the authors reproduced a table (op cit p 208 Table 2) from Paffenbarger's *Harvard Alumni Study* (Paffenbarger et al 1984) showing that death rates from coronary heart disease actually declined in an inverse linear trend as volumes (kcal/wk) of physical activity expenditure increased. The most relevant data from that table are reproduced here as Table 6.1.

Table 6.1

Cause-Specific Death Rates per 10,000 Man-years of Observation Among 16,936 Harvard Alumni, 1962-78, by Physical Activity Index (selected data)

Cause of Death	Physical Activity Index Kcal per week			One-tail test for trend, P
	<500	500 - 1,999	> 2,000	
Total cardiovascular diseases N=840	39.5	30.8	21.4	<.001
Coronary heart disease N=441	25.7	21.2	16.4	<.002

Source: **Paffenbarger et al 1984** Table 2 p 49. Adjusted for differences in age, cigarette Smoking, and hypertension.

The figures in **Table 6.1** only include the death rates for cardiovascular and coronary heart disease, because Haskell and colleagues made their assertion specifically about 'coronary heart disease'. When all-cause mortality was considered the overall inverse trend from the Harvard Alumni data was less linear. But this appears to reflect the fact that 'physical activity levels' show far less impact on cancer (with the exception of colon and possibly breast) and deaths from unnatural causes (accidents and suicides).

6.2.1 Summary of Haskell et al 1985:

Haskell and colleagues, writing under the aegis of the Centers for Disease Control (CDC), appeared to put forward a public health prescription for physical activity based not only on scientific evidence, but also upon their own social perceptions of how a largely sedentary American public might be convinced to follow their healthy advice. They asserted, without stated evidence or references, that many people did not like vigorous exercise which is linked more with narrow aerobic fitness than to related, but broader health outcomes. They frequently used the term ‘levels’ of activity, a description that failed to distinguish the intensity of physical activity from accumulated volume of energy expenditure. They asserted that the greatest benefits in coronary heart disease incidence were seen between individuals “who do almost nothing” and those who get some exercise “by moving their bodies around” (**Haskell et al 1985 p 208**) Yet they presented conflicting data showing that the dose-response curve was linear in kcal/wk terms for coronary and cardiovascular disease risk reduction. They further accepted that ‘lower intensity’ exercise may require more time and produce ‘results’ which were only ‘somewhat similar’ to higher intensity aerobic training. In public health terms, however, these scientific drawbacks were portrayed as social virtues since ‘lower intensity’ activities were, Haskell believed, more acceptable to a larger proportion of the target sedentary population and the medical risks to them fewer.

However, this ‘target-the-sedentary’ approach failed clearly to distinguish between the health benefits achieved when individual sedentary people more frequently adhered to increased activity (something is better than nothing for each individual) – and the total ‘public health’ benefits that might accrue in sheer population terms because sedentary Americans far outnumber moderately active and very active Americans, combined.

This latter concept, population attributable risk (PAR), was explored subsequently (see Chapter 8) and in greater depth by Paffenbarger and Blair (**Blair et al 1992**) and Powell and Blair (**Powell and Blair 1994**).

6.3 Benefits of Vigorous Activity Still Reported: Siscovick et al 1985

A consensus in favour of moderate intensity guidelines, led by Haskell and Blair, may have been emerging in the 1984 CDC workshop. However, conflicting evidence was also presented at the same time, most notably by Siscovick and colleagues (**Siscovick et al 1985**) when they reviewed the scientific literature on the benefits and risks of physical activity in specific relation to four diseases and conditions: coronary heart disease, hypertension, diabetes mellitus, and osteoporosis. Once again, the authors' primary focus was on coronary heart disease, and they were unequivocal that on existing evidence examined by their critical review: "Habitual vigorous physical activity is associated with a reduced overall risk of coronary heart disease (CHD) and sudden cardiac death." They further concluded that "those with hypertension or obesity may particularly benefit [from habitual vigorous activity]." (**op cit p186-87**)

Siscovick's own research interests included the increased incidence of primary coronary arrest during and immediately after vigorous exercise – a concern expressed then, and later among public health professionals. (**Curfman GD 1993a, 1993b, Lakka et al 1994 and USSG 1996 p 144**). But the authors concluded: "...although the risk of primary cardiac arrest is transiently increased during the act of vigorous exercise, men who are habitually vigorous have a lower overall risk of primary cardiac arrest than sedentary men." (**Siscovick et al 1985 p 183**)

However, the authors expressed an important caveat to their 'vigorous' recommendation: Insufficient study had been given, they said, to determine whether, and if so by how much, less intense physical activity might also provide health benefits reducing risk not only from coronary heart disease, but other specified diseases: They concluded:

"Whether vigorous activity, such as jogging, that results in physical fitness is necessary to achieve the disease-specific benefits of physical activity remains unclear, because previous studies have not adequately examined the relationship between less intense activity, such as walking, and these diseases. There is need for research that clarifies the type, intensity, frequency, and duration of activity required to maximize the potential disease-

specific benefits and minimize the hazards of physical activity....The lessons learned from more than 30 years of investigations related to physical activity and coronary heart disease should guide the research activities that address these issues. The public health and clinical significance of these questions requires that they be examined in the most rigorous manner feasible.” **(op cit pp 186-187)**

6.3.1 Summary of Siscovick et al 1985

The cited references in their review show that Siscovick and colleagues relied heavily on the large epidemiological studies of Morris and Paffenbarger when concluding that vigorous activity played an important role in reducing the risk of coronary heart disease – at least in white middle class (or higher) middle aged men. Siscovick and colleagues did not rule out the potential benefits of ‘less intense activity, such as walking’, arguing that research in this important public area needed urgent clarification. Their conclusions, based on literature reviews, about the other disease-specific (e.g. hypertension, diabetes and osteoporosis) benefits of physical activity were less clear, both in the efficacy and intensity of the dose administered. As we shall see, physical activity, whatever its dose (type, intensity, frequency and duration) appears to have its greatest beneficial impact on the cardiovascular diseases. When advocated and applied as a public health tool across other specific diseases and conditions, its efficacy would become harder to evaluate, and this would be reflected in the US Surgeon General’s 1996 report.

6.4 A Thorough Review: *Physical Activity and the Incidence of Coronary Heart Disease* (Powell et al 1987)

Shortly after the workshop Powell and colleagues set out to produce a definitive review of the physical activity literature in an attempt better to define, and refine, the impact of physical activity on heart health in the context of public health. The authors focused on 43 post-war experimental and observational studies (beginning with Morris et al 1953) that met their selection criteria.

One might have imagined the review would have been able more precisely to examine

evidence from existing studies about the vexed issues discussed above: what role (if any) intensity of activity played in reducing CHD risk and incidence – and further: what impact increasing (or decreasing) intensity had upon the fundamental public health issue: adherence. Yet, when the authors examined each study for precise information about the “measure” or ‘dose’ of activity, they discovered:

“The measure [dose] should include information about the frequency, duration, and intensity of the activities encompassed. Only eight studies (19%) specifically included all of this information in their measurement of physical activity.” **(op cit Powell et al 1987 p 262)**

When Powell and colleagues next examined the 36 cohort studies for information on ‘adherence’ they must have been even more frustrated:

“For cohort studies, adherence to the original physical activity classification should be determined. Only three (8%) of the 36 cohort studies obtained this information or even considered this issue in their analysis.” **(op cit p 262)**

Given this evident paucity, therefore, of a strong evidence base regarding both ‘dose’ and ‘adherence’, it may seem difficult to understand how the proponents of a switch to new public health guidelines, away from vigorous activity in favour of moderate, and more time consuming activities, could have been so certain that their new formula would prove effective in improving the health of the American people.

Indeed, important aspects of Powell’s review appeared to favour maintenance of vigorous intensity public health guidelines. For example, when examining evidence on (‘good’) HDL cholesterol, Powell and co-authors noted eight studies where:

“HDL levels are increased in endurance athletes, in sedentary men after exercise training, and even in men who simply report some regular strenuous activity. Vigorous activity also reduces fasting triglyceride concentrations and augment intravenous fat clearance.” **(op cit p 280)**

However, it should be noted that many, and especially early, clinical investigations will have favoured interventions with small populations that focused on strenuous exercise, and thus the absence of evidence in favour of moderate intensity activity should be weighed in that light. As shall be seen in later chapters, at least two teams of modern

investigators (**Duncan et al 1991 and King et al 1991, 1995**) would soon attempt to redress this imbalance with studies which appeared to show that modest regimes of moderate intensity activity could significantly improve HDL levels, indeed even more so than more vigorous activities.

In summary, Powell and colleagues' review concluded that: "The existing literature supports the conclusion that an inverse association exists between physical activity and CHD." (**op cit p 282**) However, it highlighted other important weaknesses in the physical activity literature: first, Its excessive concentration upon working aged men, to the exclusion of women and older men:

"Since few studies provide information about women or older men, it is important to determine whether the association holds for them as well as middle-aged men." (**op cit p 282**)

They further noted the frequent and persistent failure accurately to measure not only dose (frequency, intensity and duration), but also and quite separately, adherence. Indeed, the authors asked: "How important is the intensity of the activity and what is the value of low-intensity activities?" (**op cit p 282**)

6.4.1 Powell KE 1988

The 1987 review by Powell and colleagues was, and remains, frequently cited in the physical activity and public health literature. Shortly after its publication the review also became the cornerstone of a meta-analysis extracted from its data and some subsequent studies by health epidemiologists Berlin and Colditz which confirmed a broad association between "high activity levels" and protection from "major cardiovascular events". (**Berlin and Colditz 1990 p 624**).

However, much less often cited has been a chapter written by Powell alone which appeared a year after the review (1988) in a book on exercise adherence and public health edited by RK Dishman. The chapter was titled: *Habitual Exercise and Public Health: An Epidemiological View*. While evidently less influential as a review (if citation frequency is a relevant measure) it is examined briefly here because it focused more closely upon the central research question of this dissertation: Was the growing impetus

to change public health emphasis from vigorous to moderate intensity physical activity based on robust and reliable scientific evidence alone, or was it also influenced by social considerations?

Powell again addressed two issues examined in the 1997 review: the poor quality and/or paucity of comparable data on the accurate measurements ('dose') of physical activity, and secondly the inadequacy of data and methods to measure likely adherence (the 'determinants') to any exercise/physical activity programme, or self-initiated lifestyle. However, Powell also chose to consider, in some detail, the key matter of intensity: whether vigorous activity was superior (in its health benefits and likely adherence) to less strenuous (moderate) activities.

As to measurements of physical activity 'dose', Powell again observed:

"One of the major deficiencies of past research in this area has been the absence or imprecision of clear definition of the behaviour being studied. At the very least, exercise should be described in terms of the type, frequency, duration and intensity at which it is conducted. The variable specificity of the definition of activity has made it difficult to compare the results of previously reported studies." **(Powell KE 1988 p 17)**

Powell further acknowledged that only in the study of coronary heart disease (CHD) was the physical activity data adequate to make accurate public health judgements and recommendations: "With the exception of CHD, however, the data are insufficiently developed to quantitatively predict the magnitude of the [public health] benefits". He even acknowledged that the entire "scientific foundation" of the discipline might appear insufficient:

"Given the fact that almost all the benefits and risks [of physical activity] remain to be quantified....the proper course of public health policy is unclear. One could argue that the public health activities outlined previously have already exceeded the scientific foundation for the area. However, this is not the case.... Although not yet well quantified, the evidence in support of the public health importance of physical activity and exercise is well enough established to deserve public support." **(op cit p35)**

Yet, in his own review and summary (within the chapter) of the importance of physical activity in the prevention of coronary heart disease, Powell himself appeared to have no choice but to use the imprecise amalgam term ‘levels’ of physical activity to draw conclusions because the studies under his review could not be accurately compared, not least because they so consistently failed to declare, define and test the precise measures (‘type’, ‘frequency’ ‘duration’ and ‘intensity’) of physical activity in their research methodologies. Thus he needed to conflate these precise measures into a composite. He seemed, almost paradoxically, to transform this lack of comparability and completeness into a virtue:

“A number of studies have examined the relationship between coronary heart heart disease and levels of physical activity....Taken altogether, the studies document the inverse relationship between level of physical activity and incidence of CHD. The relationship has been observed in a variety of population groups, using a variety of CHD endpoints, and using several different methods to measure physical activity. The general consistency of the findings obtained in a variety of settings with a variety of instruments is persuasive evidence of the validity of the relationship.” (op cit p 19) **(emphasis added)**

Powell again observed similar problems of imprecision when examining the ‘determinants’ of population adherence to physical activity:

“Considerable research has produced a rather long list of potentially important determinants of physical activity....Unfortunately, variable methods and definitions make it impossible to say which are the most important independent factors [affecting likely adherence]. (op cit p 26)

Powell also chose to address whether the intensity of physical activity was important in protecting against heart disease. Having cited a number of studies, including recent ones from Morris and Paffenbarger, Powell concluded:

“.....persons who expended the most calories per week in habitual high-intensity activity had both the lowest rate of primary cardiac arrest during less active periods and the smallest increase in risk during episodes of activity. Thus, even though vigorous activity temporarily increases the risk of an

adverse cardiac event, people who regularly engage in vigorous physical activity are still at the least risk overall.” **(op cit p 20)**

Powell further suggested that “the best data” from recent US surveys indicated that “the increase in vigorous leisure-time physical activity is particularly marked,” although he conjectured whether this apparent increase was sufficient to offset “decrements” in energy expenditure from occupational work and increasing use of mechanised transport. **(op cit p 26)**

Thus, vigorous intensity activity was not only the most protective against heart attacks, its uptake, in population adherence terms, was evidently growing. And yet, just a few pages later, Powell seemed to suggest quite the opposite, that the greatest benefits came “at the lower end of the activity scale” when he observed:

“Examination of the data from several studies of physical activity and CHD indeed suggest that reduction in overall morbidity and mortality may actually accrue more rapidly at the lower end of the activity scale than at the upper end.” **(op cit p 29)**

What, then, did Powell mean by ‘the activity scale’? He did not offer a definition. He did, however, produce graphs from six separate studies, although only two (Paffenbarger’s San Francisco dock workers and Harvard alumni) were even partially referenced. As was discussed in earlier chapters, the association between occupational energy expenditure and CHD protection among the dock workers was broadly linear. Among the Harvard alumni the association was also broadly linear until an asymptote at around 3,000 kcals/wk (a high level of expenditure) and furthermore, ‘strenuous sports’ offered greater protection than ‘other activities’. How Powell could have suggested that CHD protection ‘occurred more rapidly at the lower end of the activity scale’ remains, therefore, unclear.

6.5 Chapter 6 Summary

Kenneth Powell set out to persuade the Centers for Disease Control and Prevention (CDC), and through it, the American public, that physical activity should be seen and promoted as a primary part of the US public health programme to reduce the incidence and prevalence of coronary heart disease and, possibly, other non-infectious diseases. In

setting up the Behavioral Epidemiology and Evaluation Branch at CDC, and linking with Paffenbarger to convene the 1984 physical activity workshop it would appear that Powell took important steps in achieving this primary goal. Although the participants at the workshop acknowledged many of the weaknesses in the young discipline's methodologies and knowledge base, they seemed almost uniformly eager to explore, and indeed promote the notion that moderate intensity activities had greater health benefits than had been previously recognised, and that these lesser intensity pursuits might be more attractive to, and be maintained at greater adherence rates by many American people who were put off by more vigorous activity. Although somewhat oddly, Powell, at least, believed adherence to vigorous leisure pursuits was rising as occupational expenditure was falling. However, this emerging public health strategy appears to have depended more on desire and conjecture than on sound, scientific knowledge base. Nevertheless, the primary participants at the workshop, and most notably Steven Blair would, as will next be explored, set out to accrue more evidence to support their 'moderate intensity/total kcal volume' hypothesis.

Chapter 7: The Mounting Evidence for Moderate Activity and Morris' Search for Consensus

7 Introduction

This chapter sets out to examine the major published epidemiological studies and intervention trials that emerged in the United States and Britain shortly after Powell's 1984 workshop on physical activity and public health: *Workshop on Epidemiologic and Public Activity and Exercise*. Focus is placed on increasing attempts by investigators to measure the impact of varying intensities of energy expenditure upon cardiovascular disease and all-cause mortality, as well as the efforts of Morris to explain the differences – and find common ground – between his 'threshold vigorous intensity' hypothesis and the 'moderate volume' hypothesis of leading American investigators.

The wider public health role of physical activity was soon reflected in a new series of epidemiological studies (1986–1991) which began with Paffenbarger's use of his Harvard University Alumni cohort to examine not just coronary heart disease, but all-cause mortality. Thus far, the differing conclusions of Morris and Paffenbarger on the importance of threshold intensity versus total volumes (kcal) of physical activity had remained an interesting, unresolved, but arguably obscure debate which appeared to concern, or to have an impact upon, few people outside of the narrow discipline of exercise science. As has been mentioned, as late as the mid 1970s physical fitness and physical education in the United States was deemed to "have no respected place in the American public health movement." (**Terris cited in Powell and Paffenbarger 1985 p 118**) The public health guideline advice on physical activity which did exist (published mainly by the American College of Sports Medicine and the American Heart Association) continued to attract little debate within the wider public or media and remained unchallenged at 20 minutes of vigorous exercise 3 times a week.

However, the period between 1986 and 1991 saw the publication of six key epidemiological studies that would broaden the 'vigorous v moderate' physical activity debate and begin to bring it into the wider, public health arena. Indeed, one of the studies (**Blair et al 1989**) would be reported widely in the popular press (including front page

coverage in the New York Times) **(personal communication with SN Blair, London September 2006 and Hilts PJ 1989).**

7.1 Paffenbarger et al 1986: Epidemiological Research Widens to Include All-Cause Mortality

In the wake of the 1984 CDC workshop, Paffenbarger and colleagues widened their longitudinal investigation of LTPA in the Harvard Alumni Study to include not only cardiovascular disease, but now also to a thorough examination of all-cause mortality in a large longitudinal study **(Paffenbarger et al 1986)** The results were broadly similar to the group's earlier work on cardiovascular disease **(Paffenbarger et al 1978)** but they included some illuminating differences that would help shape the physical activity guidelines debate that was about to emerge.

The same Harvard alumni cohort was used in a 12 to 16 year follow-up (1962 – 1978). Once again the primary focus was upon total volume of energy expenditure (miles walked, stairs climbed, light and vigorous sports) and the primary 'cut point' was 2,000 kcal/wk, although energy expenditure within this 'physical activity index' was further subdivided into 500 kcal bands ranging from <500 to ≥3,500. However, calculation of vigorous or strenuous sports was also made with vigorous being defined as ≥10 kcal/min, considerably higher than the ≥7.5 kcal/min threshold first advanced by Morris **(Morris et al 1973)**

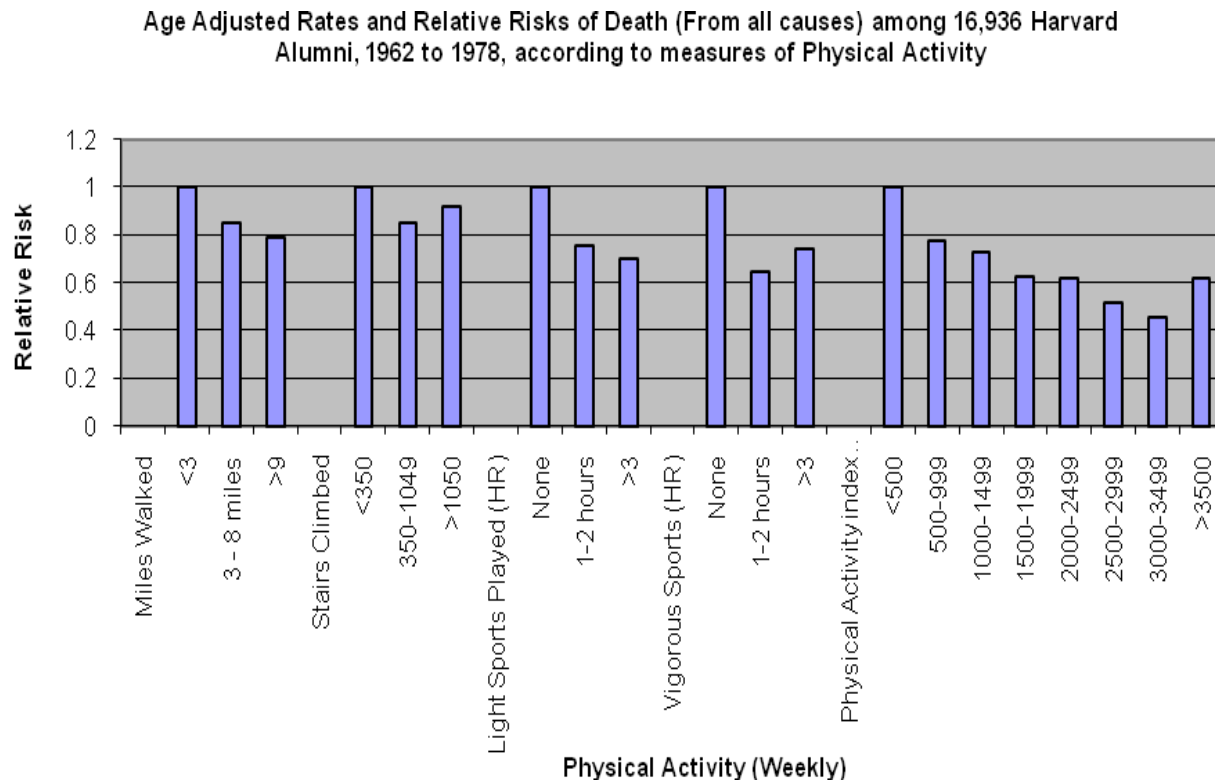
7.1.1 Moderate Activity (Walking) and Vigorous Sports Compared

Once again, this study design included only limited examination of the comparative benefits of moderate versus vigorous activities. For example, a 21 percent lower risk of death was seen among individuals who walked 9 or more miles per week, compared to those who walked fewer than 3. **(Paffenbarger et al 1986 p 606)** While described as 'a small gradient effect', this result would fit reasonably well with the coming assertion that moderate amounts of moderate activity could bring substantial and statistically significant health benefits.

On the other hand, a 35 percent lower risk of death was seen among individuals who played vigorous sports for just 1-2 hours a week, compared to those who played none **(op**

cit 606-7). Again, this finding was in line with the then current guideline to exercise vigorously for a minimum of 3 X 20 minutes per week. It was also in line with the team's previous finding with cardiovascular disease (**Paffenbarger et al 1978 p 171 fig 5**), that vigorous physical activity at ≥ 3 hours per week brought no further improvement, and actually reversed the beneficial trend to just 26 percent. The full 'physical activity index' from the 1986 study which was published as a table, is reproduced here in **Figure 7.1**

Figure 7.1



Source: **Paffenbarger et al 1986** (Table 1 p 607). Light sports played data excludes subjects who also played vigorous sports. Vigorous sports played includes subjects who also played light sports. P for trend: miles walked 0.0009; Stairs climbed 0.0646; Light sports <0.0001; Vigorous sports <0.0001; Physical Activity Index <0.0001

7.1.2 All-Cause and Cardiovascular Mortality Compared

The authors then considered the comparative impact of physical activity on cardiovascular disease and death with other causes of mortality. They concluded:

“Underlying causes of death were cardiovascular disease in 45 percent, cancer in 32 percent, other natural causes in 13 percent, and trauma in 10 percent.” **(Paffenbarger et al 1986 p 606)** “A decline in death rates with increasing activity was seen for each cause (of death) but was strongest and most significant in relation to cardiovascular and respiratory diseases.” **(op cit p 607)**

7.1.3 Summary of Paffenbarger et al 1986

The overall findings were broadly consistent, therefore, with Paffenbarger's earlier studies focusing exclusively on cardiovascular disease and death. The paper did not allow examination of death rates from individual disease causes. But looked at collectively, all-cause mortality fell in a linear fashion with increasing physical activity up to 3,499 kcal/wk when a slight rise in mortality was observed at $\geq 3,500$ kcal/wk. While Paffenbarger and colleagues were primarily concerned with total volumes (kcal) of physical activity, they did observe a significant risk reduction from all cause mortality among men who played 1-2 hrs/wk vigorous sport, compared to those who played none.

Finally, and has been noted earlier, the Harvard alumni cohort may, given their education, single sex and socio-economic status, have been unrepresentative of the wider American population. Indeed, Paffenbarger and colleagues made this point themselves in their concluding discussion:

“The Harvard alumni may not be typical of the general population. Their age-specific death rates from each major cause except suicide were roughly half the 1980 rates for white males in the United States. (In contrast, rates of self-destruction among the alumni were 50 percent higher than suicide rates in the general population).” **(op cit p 612)**

7.2 Leon et al 1987

The next important longitudinal study to emerge was reported by Leon and colleagues **(Leon et al 1987)** in the Journal of the American Medical Association (**JAMA**). Its findings would be quoted repeatedly in following years by other investigators who would play influential roles in shaping the moderate physical activity guidelines that would be

promulgated in the US Surgeon General's 1996 report. **(Blair et al 1989, Pate et al 1995)**. The focus of the paper was coronary heart disease and death, and its conclusion, with public health now very much in mind, was that relatively modest amounts of moderate intensity leisure time physical activity (LTPA) was the best prescription to reduce heart disease incidence, death and population prevalence.

More than 12,000 men aged 35 to 57 were enrolled in the study. They were divided into tertiles on the basis of self-reported daily leisure time physical activity answered by questionnaire. Men at 7 years follow up who were moderately active (tertile 2) for around $\frac{3}{4}$ hr/day had only 63% as many heart attack deaths as those who were inactive. Mortality rates among the most active (tertile 3) of men was "similar". **(Leon et al 1987 p 2388)**. Overall, the results supported moderate activity: The authors concluded:

"This is an encouraging finding from the preventative medicine and public health standpoint, since most people should be able to schedule this amount of LTPA (Leisure Time Physical Activity) as part of their daily routine." **(Leon et al 1987 p 2394)**

However, several key characteristics of this study appear to leave it, and its findings, open to question as a suitable 'public health' model. First, the cohort of 12,138 middle-aged men was specifically selected because they were asymptomatic, but at very high risk of a heart attack: Leon and colleagues described them as:

"....in the upper 10% to 15% of a risk score distribution derived from *Framingham Heart Study* data but with no clinical evidence of CHD. The risk score was based on levels of cigarette smoking, diastolic blood pressure, and serum cholesterol." **(op cit p 2388)**

Second, the men, whose physical activity and fitness levels were assessed at baseline by self-reported questionnaire and by treadmill test, were clearly unfit by US national standards:

"The cohort as a whole was relatively unfit, with the most active tertile only average in fitness for their age, and only about 5% of the entire cohort reported the usually recommended quality and quantity of exercise to significantly improve cardiorespiratory endurance." **(op cit p 2393)**

At the time of this study, the recommended guideline referred to would have been that proposed by the American College of Sports (ACSM 1978 and updated 1980, 1986): i.e. 20 minutes of vigorous intensity LTPA for 3 or more times a week. Yet, even if it is reasonably assumed that the 5% were all in the most active tertile, this subset was reporting a truly staggering 134 minutes of LTPA a day. **(op cit 2390)** Even at non-vigorous (light to moderate) intensities this is more than four times the duration of physical activity that would become the benchmark public health prescription of investigators like Leon, Blair and Pate, and subsequently: the 30 minutes of moderate intensity activity 5 times or more a week which would become the US Surgeon General's recommendation in 1996. And yet they were 'only average in fitness for their age'.

At least two, quite conflicting conclusions, might be drawn from this disclosure. Either the men of the third tertile lied to the investigators about the duration of their daily LTPA, or even such extreme amounts of light-to-moderate LTPA failed to lift them above even average fitness. If the former, the accuracy and value of such self-reported epidemiologic evidence must be seriously questioned. If the latter, then even very large amounts of moderate intensity activity failed to approximate the cardiorespiratory fitness that vigorous activity had been shown to achieve in much shorter periods of time. **(Morris et al 1973, 1980, Paffenbarger et al 1978)**

7.2.1 Summary of Leon et al 1987

Given these limitations, it would seem difficult to infer significant public health and physical activity guideline pronouncements from this study, despite its repeated citation in favour of moderate LTPA made by subsequent investigators.

7.3 Slattery and Jacobs 1988 and Slattery et al 1989

Shortly after completing her PhD dissertation on the relationship of physical activity to cardiovascular mortality, Martha Slattery began further investigation of the US Railroad study, which had begun under the direction of Henry L Taylor, a colleague of Ancel Keys at the University of Minnesota (see Chapter 4 for earlier discussion of Taylor's study). Using similar methods to Morris **(Morris et al 1953)** Taylor won the co-operation of the US Railroad Retirement Board, which opened up its "reliable and accurate" occupational death

rate data to him. **(Taylor et al 1962 p 1697-8)** These data gave Taylor the opportunity to compare the death rates of relatively sedentary clerks with moderately active switchmen and more vigorous section men. However, Taylor and his colleagues did not directly report upon altogether more novel data which they also collected on the more than 3,000 railroad workers from 1957 to their deaths or until 1977 when the study was terminated.

Aided by a grant from the National Institutes of Health, Taylor and his colleagues equipped a Pullman railroad car with anthropometric measuring tools including an exercise treadmill and set off around the western railroads of the United States in 1957. **(Blackburn H 2007)** Their twin aims were to measure both the fitness of the railroad workers by measuring exercise heart rate, and also to enquire about their leisure time physical activity (LTPA) through a self-report questionnaire. Thus Taylor and colleagues were the first to report a major occupational study on physical activity and heart disease which, unlike Morris' busmen and conductors, offered a three point comparison between sedentary, moderately active and moderately vigorous men. Taylor also therefore conceived and administered his leisure-time survey well before Morris **(Morris et al 1973)** and he executed his exercise fitness test well before the large and often cited studies conducted by Leon, Haskell, and Blair in the late 1980s **(Leon et al 1987, Ekelund et al 1988, Blair et al 1989)**. However, while Taylor lived until 1983, the fitness and leisure-time physical activity data remained unpublished until Slattery and colleagues intervened to evaluate its importance in 1988 and 1989 **(personal communication with SN Blair September, London, October 2007)** Slattery and colleagues expressed their gratitude:

“The authors wish to acknowledge their debt to the late Dr Henry L Taylor, Director of the US Railroad Study, whose death in 1983 prevented his involvement in the work presented here. The questionnaire used by the authors to quantify leisure time physical activity is Dr Taylor's conception.” **(Slattery and Jacobs 1988 p 571).**

Slattery and Jacobs began their evaluation of the US railroad data by summarising ‘the methods pertinent to the research’ which they had drawn from Taylor's work. While both they and Taylor were primarily concerned about coronary heart and cardiovascular disease, all-cause mortality was also recorded from death certificates supplied by the railroad board. Men with pre-existing cardiovascular disease were excluded. The cohort, which was divided into quartiles, was examined between 1957-1960 and re-examined in

1962-1964. Other recorded variables were systolic blood pressure, 'serum' cholesterol, smoking, obesity and 'economic status'.

The broad conclusion of Slattery and Jacob's analysis showed that fitness (as measured on a treadmill by exercise test heart rate) reduced risk of death from both coronary heart disease and all mortality in a strong and linear way, as can be seen in **Table 7.1**. However, much of this protection was attenuated after adjustment for age plus other coronary risk factors, and particularly, high blood pressure:

Table 7.1

Risk Estimates from the Proportional Hazards Regression of All-cause and Coronary Heart Disease Mortality by Level of Exercise Test Heart Rate in Men Free of Pre-existing Cardiovascular Disease (CVD) at Baseline Examination (n = 2,431): the US Railroad Study

Exercise Test Heart Rate (beat/min)	All-Cause Mortality		Coronary Heart Disease Mortality	
	Age	Age+CVD Risk Factors	Age	Age+CVD Risk Factors
105	1.00 (referent)	1.00	1.00	1.00
115	1.12 (1.06-1.18)	1.07 (1.02-1.13)	1.13 (1.04-1.22)	1.06 (0.98-1.16)
125	1.25 (1.18-1.31)	1.15 (1.10-1.21)	1.27 (1.17-1.38)	1.13 (1.04-1.23)
135	1.39 (1.32-1.47)	1.23 (1.17-1.30)	1.43 (1.28-1.56)	1.20 (1.10-1.26)

Source: **Slattery and Jacobs(1988)** Table 8 p 576. CVD risk factors include systolic blood pressure serum cholesterol level and cigarette smoking status. 95 % confidence intervals in parentheses.

While the protective effect was relatively small at baseline, the authors reported that it increased significantly at the second examination and observed that there was only "small variance" in fitness within the population, which made assessment more difficult. Unfortunately, Slattery and colleagues made no evident attempt to examine any correlation between occupational activity and fitness level and commented simply that: "There were few, if any men who were highly trained athletes who had developed a high level of fitness through training." (**op cit p 578**)

7.3.1 Leisure Time Physical Activity Data from Taylor's Study also Examined

When Slattery and colleagues turned, in the following year, to report on Taylor's leisure time physical activity (LTPA) questionnaire data, they concluded broadly that: "These results support the hypothesis that physical activity protects against death from coronary heart disease and all-cause mortality". **(Slattery et al 1989 p 304)** However, what emerged less clearly was whether the key protective factor was duration and total volume (kcal) of energy expenditure, or threshold (vigorous) intensity. The questionnaire used was an early version of the Minnesota Leisure Time Questionnaire which would become the standard in American exercise physiology and epidemiology. As such, it contained over 50 activities which were given an intensity code and divided into light, moderate and intense categories. Slattery and colleagues posed the question clearly enough:

"The hypotheses for the relation between LTPA and CHD are 1) that the total amount [kcal/wk] of activity protects against the development of CHD, and 2) that aerobically intense LTPA conditions against the risk of CHD. Therefore, analyses of the component parts of LTPA were examined to determine the influence of intensity of the activity on the LTPA and CHD mortality relation."

(op cit p 306)

However, the authors' conclusions were far from conclusive on this central issue. A big obstacle was: "Relatively few men performed substantial amounts of intense LTPA....Only 279 men reported more than 250 kcal/wk of intense activity. This cut-off point corresponds to less than 5 min/day of activity, such as jogging, at an intensity level of eight." **(op cit p 306)** This duration was much less than the minimum of 15 minutes of continuous intense activity, postulated by Morris, to confer significant heart attack protection.

From an early 21st century perspective it is perhaps unsurprising that 'relatively few' American railroad workers would have chosen in the late 1950s and early 1960s to engage in any regular, intense leisure time physical activity. Many will have been engaged, as Taylor's study showed, in occupational activity that was at least moderately active on an hourly and daily basis, and few would have had access to and/or discretionary income for intense leisure activities other than jogging/running or cross country hiking among the intense activities listed on Taylor's questionnaire which also included more esoteric pursuits such as racket sports, competitive canoeing and skiing (snow and water). **(op cit p 305)**

Despite these limitations, however, Slattery and colleagues did draw some conclusions about the two energy expenditure hypotheses they proposed. However, their conclusions appear to have been at best confusing, at worst conflicting.

On the one hand, they found evidence for the volume hypothesis: “All-cause and cause-specific death rates generally decreased with increasing total LTPA.” **(op cit p 306)** In addition, the reduction continued in a linear gradient until total activity expended exceeded 2,000 kcal/wk, an asymptote similar to, albeit lower than, the ones reported by Paffenbarger **(Paffenbarger et al 1986, 1993)**.

However, Slattery and colleagues appeared also to find partial evidence for the threshold intensity hypothesis, because “any” vigorous activity proved protective against CHD whereas “substantial” light or moderate activity was required to achieve the same effect:

“Substantial light and moderate activity or any intense LTPA or both were independently related to CHD risk.....those who reported any intense activity, with an age-adjusted geometric mean as small as 96 kcal/wk of intense activity, were at lower risk of CHD mortality.” **(Slattery et al 1989 pp 309-310)** Further, they concluded: “Thus, the ‘benefit’ achieved by 100 kcal/wk of intense activity seems about equal to that achieved by 1,000 kcal/wk light and moderate activity.” **(op cit p 310)**

Nevertheless, the authors’ final, concluding sentence appeared to be inconsistent with their previous observation upon the overwhelming superiority (per kcal expended) of intense or vigorous activity: “Thus, these data show that increasing physical activity, particularly of a light-to-moderate intensity, is appropriate to prevent disease and to promote health.” **(op cit p 310)** The authors did not seek to explain or clarify this evidently incongruous, and arguably anomalous interpretation of their own reported findings.

7.4 Ekelund et al 1988

Another important longitudinal study was reported by a team **(Ekelund et al 1988)** led by William Haskell, an investigator who played a prominent role in the 1984 CDC Physical Activity Workshop. **(Haskell et al 1985)** Although Haskell strongly argued then for a new

moderate intensity public health guideline, the results of this study of 3,106 healthy white men aged 30-69 showed (at 8.5 year follow-up) a strong inverse linear relationship (protective effect) between 'strenuous physical activity' and deaths from coronary heart and cardiovascular disease. In comparison, the protective effect was more modest among men of lesser fitness as measured at baseline by treadmill test.

It is noteworthy that women as well as men, without selection by age, race or ethnic group, were recruited for this 1977 investigation known as the Lipid Research Clinics Mortality Follow-up Study. However, the authors noted:

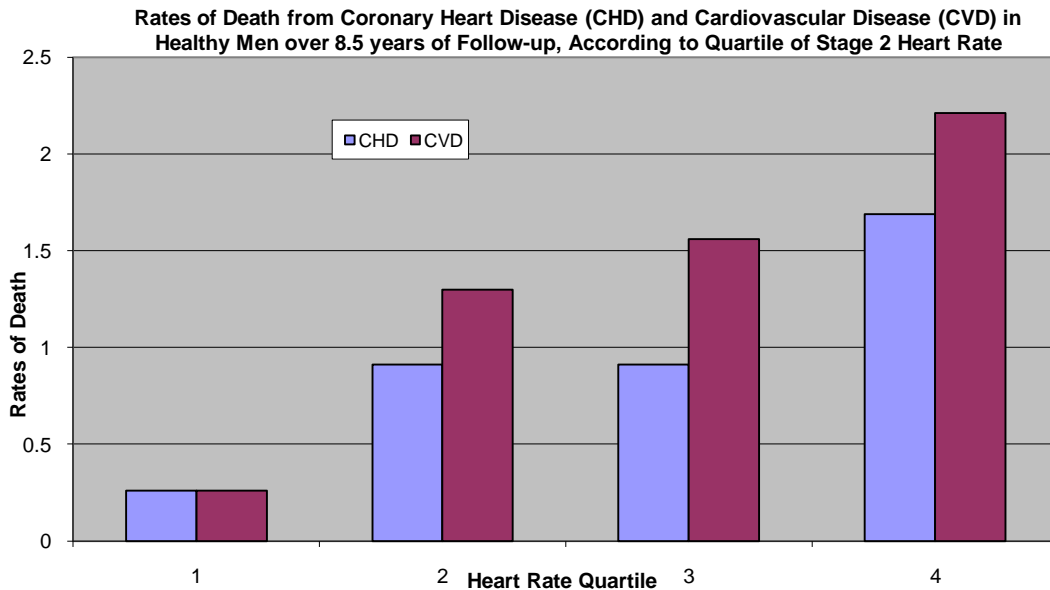
"Because of the small number of nonwhites and very elderly subjects, and because of the low incidence of cardiovascular death among women, the present study was restricted to white men 30 to 69 years of age at base line."

(Ekelund et al 1988 p 1380)

In their methods section the authors defined 'regular physical activity' in a questionnaire as: 'strenuous exercise or hard physical labour' although they did not subsequently attempt to define its intensity by kcal/min of energy expenditure or by METs (metabolic equivalent of tasks). The cohort was then tested by treadmill to ascertain quartiles of fitness, with the fittest assigned to the first quartile, and the least fit to the fourth. "Forty nine percent in the most fit quartile according to heart rate reported regular physical activity, whereas 19 percent did so in the least fit quartile." **(op cit p 1381)** An association was thus drawn between regular strenuous physical activity and fitness level. The authors further observed:

"The unadjusted cumulative mortality was much higher in the quartile with the lowest level of fitness than in the most fit quartile; the rate of death from cardiovascular disease was 8.5 times higher and that of death from coronary heart disease was 6.5 times higher. Adjustment for age did not change that relation; therefore, only the unadjusted data are presented." **(op cit p 1381)**

This tabular data from the paper is re-produced as **Figure 7.2** overleaf.

Figure 7.2**Rates of Death from CHD and CVD in Healthy Men**

Source: **Ekelund et al 1988** (Table 3 p 1382). Heart Rate Quartile 1 represents the quartile of men with the lowest heart rates (most physical fit) and 4 the quartile with highest heart rates (least physical fit). 95% confidence intervals by quartile were: CHD 0.00-0.62, 0.24-1.58, 0.24-1.58, 0.77-2.61 and CVD 0.00-0.62, 0.49-2.11, 0.68-2.44, 1.16-3.25. Ratio of death rates (4:1) CHD 6.5 (1.5-28.7) CVD 8.5 (2.0-36.7)

The authors reported: “In our study, the crude mortality rate was much higher in the least fit quartile as compared with the most fit.” (**op cit p 1382**) They went on to suggest that the biological mechanism for this improved result was “that the myocardial oxygen supply is enhanced as a result of intense physical training.” (**op cit 1383**)

7.4.1 Summary of Ekelund et al 1988

On the evidence presented, this study by Ekelund, Haskell and colleagues clearly supported the notion that there is a strong, inverse and linear relationship between physical fitness/‘strenuous’ exercise and cardiac death. Thus, this protective effect was less evident among moderately fit men (quartiles 2 and 3) than it was among the fittest men (quartile 1). However, the authors did not seek to define (in kcal/min or METs) the minimum intensity energy expenditure needed to be classed as ‘strenuous’ or vigorous. Moreover, they concluded their paper with two observations apparently incongruous to their main findings: First, they cited research which concluded that “increased platelet

aggregation has been shown in normal subjects [immediately] after strenuous exercise” – after explaining that such ‘aggregation’ or coagulation may lead to “thrombosis of the coronary arteries [which] acts as a mechanism of myocardial infarction and sudden cardiac death.” (**op cit p 1383**) The explanation may be that this lethal condition is induced when unfit individuals suddenly attempt to perform strenuous activities – a common concern among cardiologists and exercise physiologists (**Siskovick et al 1985 and Curfman GD 1993a, 1993b**).

However, the authors further cited research showing that this dangerous ‘aggregation’ was lowered among men ‘mildly hypertensive and overweight’ with an exercise programme based upon “brisk walking to slow jogging” (**Ekelund et al 1988 pp 1383-84**) Their conclusion therefore appears to have been, that ‘brisk walking’ should be considered as the minimum form of ‘strenuous exercise’ suitable, in public health terms, to reduce heart attack death risk among populations prone to risk factors such as overweight and raised blood pressure.

Ekelund and Haskell clearly found a strong, inverse linear trend which unequivocally most favoured the fittest quartile of the population. Yet their concluding advice, in public health terms, was perhaps more modest and somewhat inconsistent with their clinical findings: that individuals, and especially those with known risk factors for heart disease, should aim for more moderate attainments such as ‘brisk walking or slow jogging’ activities which might, or might not, confer a fitness level equivalent to that enjoyed by members of quartile 1 in their studied cohort.

7.5 Blair et al 1989: The Public Health Case for Moderate Activity and Fitness is Verified

In 1989 Steven Blair and colleagues (including Ralph Paffenbarger) published the first major results from the Aerobics Center Longitudinal Study (ACLS) on physical fitness and all-cause mortality (**Blair et al 1989**) which was part-funded by a research grant from the US Public Health Service and published in the Journal of the American Medical Association (**JAMA**). With hindsight, it would appear difficult to overestimate the importance of the paper’s findings in shaping subsequent public health thinking on physical activity guidelines.

In several ways Blair's study represented a substantial advance on any previous work, and he and his co-authors were explicit in saying so. The study looked not just at cardiovascular disease, but at all-cause mortality as Paffenbarger had done. A physical activity questionnaire was administered, and measurement of fitness was also done by treadmill testing, as Taylor, and Ekkelund and Haskell had done. For the first time in a large study, however, the large cohort included women, as well as men, and results were published on both genders "...with a large enough sample of women to permit meaningful analyses." **(Blair et al p 2400)** Like previous studies, it also tested and adjusted for risk factors including serum cholesterol level, blood pressure, smoking, fasting blood glucose levels, body weight, and family history of CHD. Finally, the study considered not only the impact of improved fitness on individual death rates – but also the "population-attributable risk" of all deaths that might be avoided if "all unfit persons became fit". "We believe that this is the only study of physical fitness and health that meets all these criteria," the authors said. **(op cit p 2400)**

Blair and his colleagues selected 10,224 men and 3,120 women who paid for private aerobic testing **(personal communication with SN Blair, London November 2004)** at the Cooper Institute in Dallas, Texas between 1970 and 1981. Patients with personal history of heart attack, hypertension, abnormal electrocardiograms, stroke or diabetes were excluded, as were individuals who failed to reach 85% of their age-predicted maximal heart rate at baseline on a treadmill exercise test. The cohort was described thus:

"Patients in this study are from middle to upper socioeconomic strata; approximately 70% are college graduates. Most are employed in professional, executive or white-collar positions. More than 99% are white." **(op cit p 2396)**

But: "On key variables such as serum cholesterol levels, triglyceride levels, and blood pressure....they are quite similar to the participants of other large epidemiologic studies....Nonetheless, our results must be generalized with caution." **(Blair et al 1989 p 2401)**

Each 'patient' (participant) was tested by treadmill to determine their cardiorespiratory fitness and then assigned to quintiles (quintile 1 least fit) reflecting their age and sex norms, and not an absolute fitness standard. The average length of follow-up was just over

8 years at which 283 deaths were identified. The investigators' primary and overall finding was unsurprising:

"Increased RR [relative risk] for all-cause mortality was significantly higher for the least-fit quintile in men, and the two least fit quintiles in women." (op cit p 2396) And restated later: "The results presented here support the hypothesis that a low level of physical fitness is an important risk factor for all-cause mortality in both men and women." (op cit p 2399)

But further analysis revealed a remarkable and unexpected finding: The data strongly suggested that the association between fitness and all-cause mortality risk reduction was not linear, as most previous studies (including Ekelund et al 1988) had suggested. To the contrary it was concave curvilinear: a very modest improvement in fitness appeared to bring very substantial benefits not only in individual, but in population terms -- whereas higher fitness levels brought only marginal gains for most participants. This is seen in **Figure 7.3**.

Figure 7.3

Relative Risk of Death: Age-Adjusted All-Cause Death Rates per 10,000 Person-Years of Follow-up (1970 to 1985) by Physical Fitness Groups in Men and Women in the Aerobics Center Longitudinal Study



Source: Data taken from **Blair et al (1989)** Table 2 p 2397. Quintile 1 represents men and women with the lowest fitness measured by treadmill test and Quintile 5 represents those with the highest fitness. 95% confidence limits by quintile: Men 2.05-5.77, 0.76-2.50, 0.81-2.63, 0.63-2.17, referent 1.0 Women 2.22-9.75, 1.09-5.37, 0.60-3.44, 0.27-2.11, referent 1.0

The drop in relative risk from quintile 1 to quintile 2 in men was swift and dramatic (3.44 to 1.37), while all other declines with increased fitness were much more modest. This asymptotic concave curvilinear slope is very similar in women. Blair and colleagues concluded:

“The major reduction in all-cause death rates in our study occurred between the first and second quintiles. There is some further decline, especially in women in the middle part of the fitness distribution, and only marginally continued reduction in death rates in the most-fit individuals. This finding has clinical and public health importance.” **(op cit p 2400)**

Moreover, Blair and colleagues used the treadmill data to calculate the ‘MET (metabolic equivalent of task) value’ at the plateau (of the asymptotic concave curvilinear slope) to determine the typical fitness value in both genders. The MET value can also be seen as the estimated maximum multiple of basic (or resting) metabolic rate (a common measure of fitness) that would be needed to achieve this positive plateau in death rates: In so doing, they underlined their public health position that moderate amounts (total duration) of moderate activity (intensity) would be sufficient to achieve large population reductions in death-rates among Americans: They concluded:

“The MET values associated with a plateau in death rates are attainable by most men and women who engage regularly in moderate exercise. A brisk walk of 30 to 60 minutes each day will be sufficient to produce the fitness standard (9 METs for women and 10 METs for men) for most men and women. These findings are also important from a public health perspective; approximately 30% of US adults are quite sedentary, and the prevalence of low fitness levels is correspondingly high.” **(op cit p 2400)**

7.5.1 Public Health and Population Attributable Risk

Finally, Blair and colleagues calculated how many lives might be saved (based on 30% prevalence of inactivity) if all sedentary Americans undertook enough physical activity to move (nudge) their fitness into the next quintile 2 category of the Aerobics Center Longitudinal Study cohort – a population which, as previously stated, they judged closely

to resemble other US epidemiologic studies. "If all unfit persons became fit, reductions in death rates of 9.0% in men and 15.3% in women might be expected." **(op cit p 2400)**

In conclusion, Blair and colleagues once again assessed the great public health importance of their findings:

"Moderate levels of physical fitness that are attainable by most adults appear to be protective against early mortality. The specificity of this effect is evidence that it is largely limited to reduced rates of cardiovascular disease and cancer deaths in the more-fit men and women. The strength of the association and the high prevalence of sedentary habits and low physical fitness levels produce high attributable risk estimates and suggest that these characteristics constitute an important public health problem that deserves remedial attention." **(op cit p 2401)**

7.5.2 Summary of Blair et al 1989

7.5.2.1 Women

Blair et al 1989 appears to have been a seminal study for several reasons. First, it studied a large enough cohort of women, and tested them by treadmill, to examine the relationship between physical activity-fitness and all-cause mortality in them. This had been a serious gap in scientific knowledge, as the authors identified:

"Physical fitness and CHD in women has not been thoroughly studied. The studies on physical activity and CHD in women are conflicting, with approximately 50% showing no advantage in the active group. Many of the physical activity questionnaires used in epidemiologic studies were developed and validated primarily on men. Many women may undertake considerable physical activity in child care and household activities. If previous questionnaires misclassify more women than men on physical activity, studies on sedentary habits and disease in women would be more likely to show no association. The objective measure of physical fitness shows similar associations to disease in women and men in the present study." **(op cit p 2400)**

7.5.2.2 Moderate Activity (Fitness), Concave Curvilinear Benefits, and the Public Health Debate

Second, the study found that individuals with only modest fitness at baseline enjoyed dramatically improved all cause mortality rates compared to the sedentary quintile at follow up, with relatively little further improvement (asymptotic concave curvilinear) for the fitter three quintiles. This pattern was seen in an almost all-white, well educated and affluent cohort whose CHD risk factor variables were, nevertheless, 'quite similar' to other large epidemiologic studies. Further, and in stark contrast to Leon et al 1987, the Blair cohort specifically excluded individuals with personal histories of heart attack, hypertension, stroke, abnormal ECG patterns, diabetes and anyone failing to achieve 85% of their age-predicted maximal heart rate. By the standards of the day, therefore, this was a cohort that, more than previous ones, appeared to reflect the fitness and disease risk factors of ordinary Americans. The conclusion, therefore, that modest amounts of moderate physical activity could dramatically improve fitness and population attributable risk of death appeared to have profound public health importance in the United States and elsewhere.

7.5.2.3 The CDC and the *New York Times*

This evident importance was borne out at both the medically scientific (clinical) and more public (lay) levels. *The Journal of the American Medical Association* chose to highlight the study's importance not only by accepting it for publication, but also by including a highly supportive editorial comment in the same edition. The editorial asked: "What physical activities should we promote?" Its conclusion was clear:

"In the study by Blair et al, the greatest reduction relative risk occurs between the lowest level of fitness and the next lowest level...These data suggest that even a modest improvement in fitness level among the most unfit confers a substantial health benefit. This finding makes our health promotion task considerably easier. Inactive individuals are likely to find lower-intensity activities, such as walking, more acceptable than higher-intensity ones, such as running. Lower-intensity activities are likely to be more comfortable, more convenient, more affordable, safer, and thus, more likely to be done." **(Koplan et al 1989)**

All three authors of the editorial were senior figures in the US Government's Center for Chronic Disease Prevention and Health Promotion at the Centers for Disease Control (CDC) in Atlanta Georgia.

Finally, on the day of publication (November 3, 1989) the *New York Times* led its front page with a 900+ words report and analysis of the importance of the Blair et al study. **(Hilts PJ, NYT 1989)** Hilts reported: "The most striking finding was that the biggest health gain came from just getting out of the most sedentary category, rather than seeking the fitness achieved by dedicated athletes." And he quoted Carl Caspersen, one of the three editorial writers, who was Kenneth Powell's deputy at the CDC: "This is a hopeful message, an important message for the American people to understand. You don't have to be a marathoner. In fact, you get much more benefit out of being a bit more active."

No mention was made, either in the JAMA editorial, or in the *New York Times* article of the alternative hypothesis, proposed the previous year by Ekelund and Haskell **(Ekelund et al 1988)**, that the correct association between fitness and mortality was broadly linear, with greatest benefits seen amongst the fittest members of the cohort who typically practiced 'strenuous' or vigorous exercise. A similar strong linear association was also seen between increasing amounts of threshold vigorous physical activity (≥ 7.5 kcal/min) and improved coronary risk factors after a re-examination earlier in 1989 of the latest results on physical activity (1,598 men, 1,762 women aged 20-69) that were emerging from the *Framingham Heart Study*. It reported that four (protective) coronary risk factors: higher HDL cholesterol, lower heart rate, lower Body Mass Index (BMI), fewer cigarettes smoked per day, all improved in a linear gradient across four quartiles of increasing physical activity ($p < 0.01$) It concluded: "Results substantiate previous reports of an inverse relation between physical activity levels and cardiovascular risk...." **(Dannenberg et al 1989 p 76)**

Not only did the evidence of Dannenberg and colleagues appear to conflict with the results that Blair would soon report (linear v curvilinear), but it appeared, at least to some extent, to support the threshold intensity hypothesis of Morris when it specifically examined the effect of what it described as "conditioning (≥ 7.5 kcal/min) activities" upon male participants: "Men who participated in at least one hour of conditioning activities per week had significantly different mean levels for these four risk factors than men who reported less than one hour of such activities per week ($p < 0.001$)." **(op cit p 76).**

These recent, and apparently conflicting results from the US government's highly regarded *Framingham Heart Study* were perhaps less likely (in a pre-internet era) to have been seen by the *New York Times*. Although published in a distinguished medical journal (*American Journal of Epidemiology*) they were not cited in Blair's own report, although they may have appeared after he submitted his work for publication. However, it may be illuminating to examine where and when these *Framingham Heart Study* results were subsequently cited: First, in the following year (1990) in the *Journal of Aging and Health*, and then not again until 1998 (in *Circulation*), two years after the *US Surgeon General's 1996 Report on Physical Activity and Health*, which also did not cite them.

7.6 Morris et al 1990: A Search for Common Ground in the Moderate v Vigorous Intensity Debate

In 1990 Morris and his British colleagues published a further phase of the 'Whitehall study', this time drawn from a new 9,000+ cohort of male executive officers aged 45-64 from the Department of Health and Social Security and the Inland Revenue in offices throughout Britain. His clear intent was to re-test his 'threshold vigorous intensity' hypothesis with a different group of subjects, arguing that it was "hazardous....to generate a new hypothesis post hoc from the same data set." **(Morris et al 1990 p 325)**

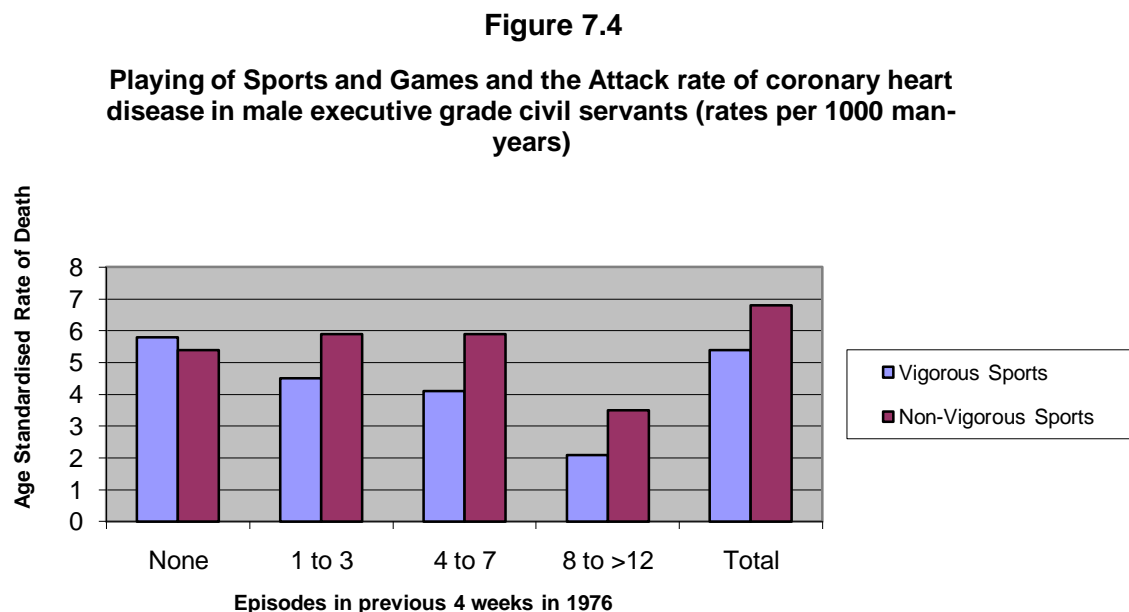
While these new results broadly supported the 'vigorous threshold intensity' hypothesis of Morris' earlier investigations **(Morris et al 1973 and 1980)**, they also appeared to leave some room to move toward a consensus and acceptance that the 'moderate intensity/volume/duration' hypothesis might also have *some* statistical merit in reducing heart disease risk.

The new British cohort was described as: "...a white collar middle management grade, a narrow though not untypical, homogeneous and stable educational/occupational/economic band of the middle class, engaged in sedentary or physically light office work." **(Morris et al 1990 p 325)** Once again, the focus was upon the association between leisure time physical activity and coronary heart disease/mortality, and subjects with clinical history of the disease were excluded. The remainder were asked in 1976 by questionnaire

to recall and record their leisure time physical activity in the previous 4 weeks. They were followed up 9 years later.

The broad conclusions confirmed Morris' earlier work with a similar cohort (**Morris et al 1973, 1980**) that threshold amounts (both minimum intensity and duration) of vigorous sports, cycling or 'brisk walking' (>4 mph or >6.4 km/h) conferred substantial reductions in non-fatal and fatal heart attacks. Morris and colleagues reported:

"The 9% of men who reported that they often participated in vigorous sports or did considerable amounts of cycling or rated the pace of their regular walking as fast (over 4 mph, 6.4 km/h) experienced less than half the non-fatal and fatal coronary heart disease of the other men." (**Morris et al 1990 pp 325**) This conclusion is illustrated in **Figure 7.4**.



Source: Data taken from **Morris et al (1990)** Table 1 p 326. Coronary attacks recorded between 1976-86. Attack rates include all recognised first coronary events, non-fatal (202 at 45-59 yrs) and fatal (272 at 45-73 yrs). P for trend; vigorous sports $p < 0.005$, non vigorous sports $p > 0.05$

While there appears to be a statistical 'out-lier' in the rate reduction among active (8->12 episodes) non-vigorous men, Morris and his team felt their primary results nevertheless verified their 'intensity threshold' hypothesis:

“The contrast between (‘vigorous sports’) and (‘non-vigorous’) is plain, corroborating the hypothesis of a threshold of intensity for effectual exercise.” **(op cit p 327)** Once that threshold (7.5 kcal/min) was reached, there were further benefits for those who increased the frequency of these vigorous sporting activities. “There is some indication too in (‘vigorous sports’) of a ‘dose response’ with frequency; the finding with 8 or more episodes of exercise – that is at least twice a week on average – reported by 3.8% of the men, is the strict test of the hypothesis.” **(op cit p 327)**

However, Morris had taken a career long interest in public health, or as he termed it, medicine from a “social health perspective.” **(Erlichman et al 2002 p 258 and personal communication with JN Morris, London April 2004)**. He would have been acutely aware, therefore, that 91% of his relatively healthy and affluent British cohort were failing to take advantage of this vigorous activity prescription. The findings of this latest paper were accepted for publication in December 1989. This was just a month after publication of Blair et al 1989, which may not have been seen even in pre-published form, was not cited by, and presumably, therefore, did not overtly influence Morris and his team. Nonetheless, Morris, while still defending his ‘minimum vigorous threshold’ hypothesis, then took several new steps (including “personal communication” with Paffenbarger **(Morris et al 1990 p 325)**) to consider reasons for differences – and agreement -- between his ‘vigorous’ findings and the primary ‘moderate volume’ hypothesis of Paffenbarger which appeared to show considerable benefits from accumulated moderate activity as well as extra benefit when, and if, vigorous activity was included. Morris observed in respect of Paffenbarger’s Harvard alumni cohort **(Paffenbarger et al 1986)** and the ‘moderate volume’ hypothesis:

“Furthermore, in an admittedly different population of American men, though players of vigorous sports showed the lowest coronary rates, there was some protection also in a minority who took less intense aerobic exercise, and thus had high totals of leisure activity (≥ 2000 kcal per week).” **(Morris et al 1990 p 325)**

To test the issue, Morris and colleagues, in effect, ‘weakened’ their ‘thresholds’ – both by intensity and duration. Instead of just distinguishing between ‘vigorous’ and ‘non-vigorous’ sports (as seen in **Figure 7.4**) they sub-divided the cohort into 4 groups of men reporting: (1) vigorous aerobic activity at least twice a week (2) less frequent vigorous or less intense exercise (3) residual aerobic vigorous –less than once a week or shorter less intense exercise (4) no vigorous aerobic exercise. **(op cit p 328)**

This 'common ground' was most clearly seen in the older (55-64 yrs) members of the British cohort when they "...reported the next lower degree [group 2] of this vigorous aerobic exercise [they] had rates less than two thirds of the remainder [groups 3 and 4]", although this benefit was not seen in the younger 45-54 yrs group. **(op cit p 325 and Table 4 p 329)**

So, for the first time Morris and his colleagues postulated some strongly significant benefits (of heart protection) among men who did not report enough vigorous exercise (either in intensity or frequency) to reach the minimum absolute threshold (7.5 kcal min for 15+ min x 2/wk) of the vigorous hypothesis. The investigators considered why this less strenuous activity may have significantly, albeit less steeply, reduced heart attack rates in these men: They suggested:

"Because major anatomical and physiological determinants of oxygen transport and physiological determinants of oxygen transport and physical working capacity decline with age, less intense exercise of the appropriate kind may be adequate to induce and maintain cardiorespiratory training. By the same token, the minority of American men [the Harvard alumni] who derive some protective benefit from even more moderate aerobic exercise (corresponding here to non-vigorous sports and ordinary 'normal' walking) may have been less healthy, active and fit on average than our participants, and thus more able to derive some benefit from less intense exercise. These are testable propositions." **(op cit p 331).**

Morris and his colleagues then went directly **(Table 7.2)** to examine Paffenbarger's hypothesis that a total weekly volume of non-vigorous activity exceeding 2000 kcal/wk alone was significantly protective against heart disease and death: "Energy expenditures were calculated in a similar way to the figures used in studies of the American men." **(op cit p 329)**

Table 7.2
Cases and Rates of Coronary Heart Attacks by Volume of Non-vigorous Activity

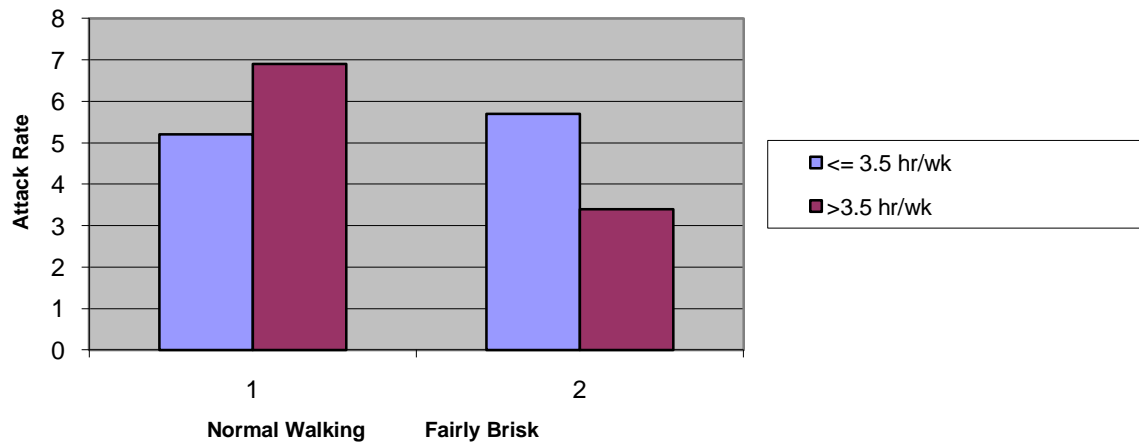
Volume of non-vigorous activity	Cases	Rate (1000 man yrs)
< 2000 kcal/wk	213	5.7
2000 – 2999 kcal/wk	113	5.2
≥3,000 kcal/wk	148	5.3

Source: Tabulated from Morris et al 1990 p 329

However, once they examined total non-vigorous activity alone, Morris and colleagues saw no association: “So for these data there was no gradient in coronary heart disease associated with total profiles of energy expenditure.” **(op cit p 329)**

8.6.1 ‘Duration and Pace’ of Walking and the Rate of Coronary Attacks

Thus, Morris and his team were, when tackling the problem head-on, still unable to find support for the simple ‘moderate volume’ hypothesis. However, they did see a significantly different picture **(Figure 7.5)** when they examined what they described as ‘duration and pace’, together. All subjects (not just the 55 to 64 yr/olds) who walked both long enough (>3.5 hr/wk), and faster than normal (‘fairly brisk’) at just under 6.4 km/h did have fewer heart attacks (a reduced rate of 3.4) than men who walked less long, and/or less fast.

Figure 7.5**Duration and Pace of Walking and the Rate of Coronary Attacks**

Source: data taken from **Morris et al (1990)** Table C p 327

Although they did not use the term, Morris and his colleagues were again examining the concept of 'relative intensity' – as opposed to an absolute and externally defined threshold – determined by such things as age and/or overall health and fitness during the time of study. Men who were older or less fit, might then, significantly benefit from less intense, more 'moderate' activity. All the men, including the younger ones, derived some significant protection from heart attacks if their walking combined a 'duration and pace' which was long and brisk --- but less intense than Morris' 7.5kcal/minute 'threshold'. This 'common ground' with Paffenbarger, and to a lesser extent with the findings of Blair, appears to have slipped, casually, into the commentary when the term "moderately intense" was introduced: Morris and colleagues said:

"Incidentally, though the term 'vigorous' is used, vigorous enough on average for a training effect in such men is intended, and in the totality of exercise 'moderately intense' might be a more appropriate term. This is particularly the case for the older cohort of 55-64 in group 2 who were observed for mortality up to 73 years of age and who showed a benefit associated with a lesser degree of the identified vigorous aerobic exercise but again not with any other form of exercise." (**op cit p 331**)

7.6.2 Summary of Morris et al 1990

Morris and his colleagues concluded broadly that their primary hypothesis was verified: a threshold intensity or training effect was necessary to reduce the risk and rate of heart disease: “Activities other than vigorous aerobic exercise were not associated with benefit in coronary rates, nor did high totals of physical activity per se – whatever their other benefits undoubtedly are.” **(op cit p 331)** Indeed, they could also find no mechanism of protection against heart attack from vigorous (7.5 kcal/min) leisure time heavy work, such as strenuous gardening or car repair, whatever the quantity or intensity. **(op cit p 328)** They concluded that this absence of protection may have been due to the fact that such ‘heavy work’ was often “periodic” or “discontinuous” **(op cit p 331)** and they added:

“This contrasts with the sustained, predominantly dynamic, rhythmic contraction of large skeletal muscles, as in swimming, walking, cycling, distance running, rowing, and the like, that was found to be protective; and such activities are more likely to be performed with greater intensity ‘for exercise’”. **(op cit pp 331-2)**

In further examining what they called ‘mechanisms of protection’ Morris and colleagues cited recent short-term intervention studies **(Andrews et al 1986, Watts and Weir 1989, Duncan et al 1985)** which suggested that exercise of sufficient intensity beneficially reduced blood risk factors such as platelet aggregation (clot formation) and blood pressure. They also cited epidemiological data **(Epstein et al 1976)** derived from Morris’ earlier civil servant cohort **(Morris et al 1973)** suggesting that vigorous exercise significantly reduced several electrocardiogram abnormalities.

However, they were able to find reduced, but still significant heart attack risk and rate benefits among the older members of their cohort who reported either less intense or less frequent vigorous activity, and among all men who undertook more moderate leisure time exercise such as large amounts (>3.5 hrs/wk) of ‘fairly brisk’ walking (‘duration and pace’). They also conjectured that the American cohort studied by Paffenbarger (Harvard alumni) may also have benefited in the same way from over all volumes of physical activity (> 2,000 kcal/wk) because they were less fit, and/or more sedentary than their British counterparts in the Whitehall studies.

Indeed, the proposed relatively greater fitness of the British cohort of civil servants may

well have been the key difference between the two investigations – allowing the less fit American cohorts (Paffenbarger and Blair) to respond to and show significant coronary and other health benefits from moderate volumes of moderate activity, as compared with very sedentary members of their cohorts. For, while Morris and colleagues could find no direct significant cardiovascular benefit from ‘strenuous gardening’ among their British cohort, they later adopted the plausible assumption that this underlying leisure time physical activity, which was regularly done by an overwhelming majority of the cohort, did improve their background fitness to the extent that additional volumes of moderate activities showed no further significant protective effect from heart disease. **(personal communication with JN Morris, London April 2004 and December 2006)**

So, in conducting this new cohort study, was Morris, the arch advocate of the ‘vigorous threshold hypothesis’ attempting (in Popperian terms) to falsify his primary hypothesis that only vigorous exercise above a 7.5 kcal/min threshold was significantly protective against heart disease? Equally, in the terms of Popper’s well documented clash with Kuhn, was he hoping, within his own ‘framework’ to find some consensus with the ‘moderate modernisers’ or were the two opposing views incompatible, or in Kuhn’s terminology, ‘incommensurate’? Although Morris’ primary finding remained that vigorous activity was the primary and superior route to coronary protection, it would seem that his search for lesser but significant benefits of ‘duration and pace’ at a lower intensity of walking and, his desire to describe ‘vigorous’ as just ‘moderately intense’, meant that he was hopeful of finding some common ground with his American co-investigators. It was perhaps just coincidence that another British team of investigators, led by Shaper, would then enter the arena.

7.7 Shaper and Wannamethee (1991)

Other leading investigators (Morris, Paffenbarger and Blair), when examining the association between physical activity and heart disease, specifically chose to exclude from their longitudinal studies any individuals with pre-existing evidence (symptomatic or asymptomatic) of heart disease. Only Leon (**Leon et al 1987**) chose deliberately a cohort all of whom were in the high risk (top 15%) category for heart disease. By comparison, Shaper and Wannamethee chose not to exclude people with existing heart conditions when they selected a cohort of British men who were patients at general practices in 24

British towns “representative of the socioeconomic distribution of men in Great Britain.” **(Shaper and Wannamethee 1991 p 384)** Of the 7710 men aged 40-59 who took full part in the 8 year follow-up study 25% of the men either had previously had an ischaemic heart attack or were strongly suspected of having developed at least early stages of the disease.

Shaper, a professor of public health and primary care at a teaching hospital in London, was, with his co-investigator, clear in his desire from a public health perspective to illuminate the ‘vigorous’ v moderate’ leisure time physical activity debate between by Morris and Paffenbarger: They observed:

“Studies in British civil servants suggest that exercise is associated with a reduced risk of coronary events only when the exercise is both vigorous and sustained. This raises the important issue of whether lesser levels of physical activity have any effect on diminishing the risk of heart attack, an issue of considerable importance in a society in which regular vigorous activity is exceptional. Studies in the United States suggest that there is a continuous relation between physical activity and protection from heart attack.” **(op cit p 384).**

Each individual in Shaper and Wannamethee’s study was assigned a physical activity score (0 to ≥ 21) after answering a lengthy questionnaire on their leisure time habits: Their scoring system is reproduced as **Table 7.3**

Table 7.3
Physical Activity Index

0-2	<i>Inactive</i> (n = 686)
3-5	<i>Occasional</i> (n = 2345) regular walking or recreational activity only
6-8	<i>Light</i> (n = 1761) more frequent recreational activities or vigorous exercise less than once a week
9-12	<i>Moderate</i> (n = 1205) cycling or very frequent recreational activities or sporting activity once a week
13-20	<i>Moderately Vigorous</i> (n = 1120) sporting activity at least once a week or frequent cycling, plus frequent recreational activities or walking; or frequent sporting activity only.
≥21	<i>Vigorous</i> (n = 513) very frequent sporting exercise or frequent sporting exercise plus other recreational activities

Source: **Shaper and Wannamethee (1991)** p 386

Shaper and Wannamethee appear to have used the words 'sporting' and 'vigorous' interchangeably. They also stated that numerical scores were based on a combination of an activity's intensity, frequency and duration. Unfortunately, they did not define their categories by empirical measures (kcal/min of EE, METs, maximal heart rate or maximum oxygen uptake -- VO_2 max). Use of terminology appears to have been imprecise, and there was also overlap. Doing 'sporting activity once a week' was sufficient evidently to

classify an individual as either 'moderate' or 'moderately vigorous'. But broadly speaking, it seems that the "13-20 moderately vigorous" category fitted most closely with Morris' benchmark definition of vigorous sporting activity as 7.5 kcal/min or 6+ METs for ≥ 15 minutes at 2X week.

By the measures used therefore, 21% of the cohort were deemed to be at least 'moderately vigorous' in their leisure time activity, while 37% were reaching at least the 'moderate' standard. Taken together, the authors observed:

"The apparent benefit of physical activity was most clearly seen in those who did moderate to vigorous activities (score ≥ 9). These men had more than a 50% reduction in the risk of heart attack compared with men who were inactive." **(op cit p 387)** However, as might be expected: "The proportion of men with definite myocardial infarction decreased steadily as physical activity increased." Removing them from the analysis: "In men without pre-existing ischaemic heart disease there was a strong inverse association between physical activity and heart attack up to levels of moderately vigorous activity".

(op cit p 388)

Above this level (score ≥ 21) the evidence was somewhat confused, but the authors concluded that risk of heart attack began to rise, particularly and surprisingly among all younger men (40-49 yrs) and all men without histories of ischaemic heart disease.

Shaper and Wannamethee also looked at any association between walking and reduced heart attack risk. Their conclusion was remarkably similar to Morris' when he combined 'duration and pace' among older men in the 1990 paper just examined **(Morris et al 1990 table 2C p 327)**:

"Regular walking was not significantly associated with the risk of heart attack, though in men without ischaemic heart disease those who walked 41-60 minutes a day to and from work (more than a mile each time at fast pace) showed a decreased risk compared with other men ($p = 0.06$)." **(Shaper and Wannamethee 1991 p 391)**

If, strictly speaking, the association was not statistically significant, the authors judged the observation to be important in analysis of an activity, 'fast pace' or 'brisk walking' at

considerable duration, which had, for previous investigators, also appeared to straddle the moderate-vigorous divide. **(Paffenbarger et al 1978, Blair et al 1989).**

Yet, Shaper and Wannamethee returned again to the superior merit of moderate bouts of more vigorous sporting activity:

“Overall, those who did any regular sporting exercise had lower rates than those who did no sporting exercise but the rate did not decrease progressively with increasing frequency of sporting activity. The lowest rates were seen in those who did sporting exercise less than three times a month. Somewhat surprisingly, those who played very frequent sports shared a similar rate to those who did no sporting activity.” **(Shaper and Wannamethee 1991 p 391)**

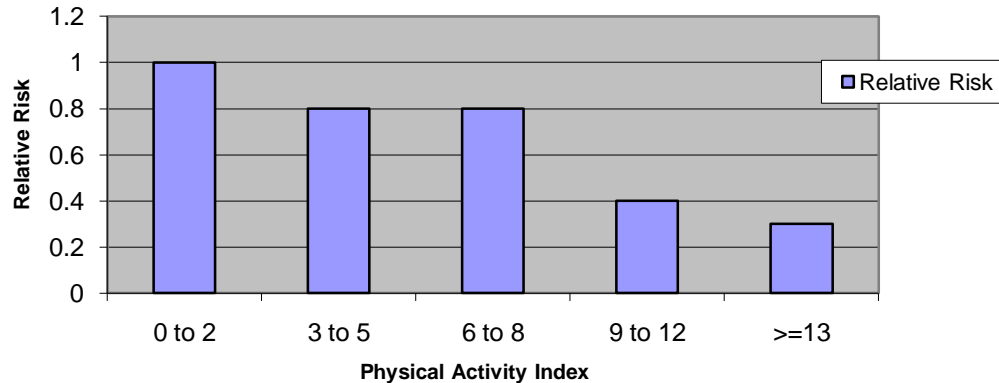
But, was sporting activity really the key to the great risk reductions? Evidently not, as individuals who did no sporting activity still managed, by the volume of their more moderate pursuits, to attain equally high physical activity scores: Shaper and Wannamethee observed:

“Morris and his colleagues have indicated that it is only regular sporting exercise that is associated with reduced rates of heart attack, whereas others have shown that frequent light or moderate activity is sufficient to produce a beneficial effect. We therefore examined the relation between the physical activity index and risk of ischaemic heart disease after excluding all men who reported doing sporting (vigorous) exercise at least once a month. The inverse relation was still seen in men without ischaemic disease and was as strong as that seen when sporting activity was included (table 6).” **(op cit p 391-2)**

Relevant data from the authors' table is reproduced overleaf as **Figure 7.6**

Figure 7.6

Adjusted Relative Risk of Heart Attack in Men without Pre-Existing Ischaemic Heart Disease According to Physical Activity Index Excluding All Men Engaged in Sporting Activity at Least Once a Month



Source: **Shaper and Wannamethee (1991)** Table 6 p 391. 95% confidence intervals : 0-2: (referent), 3 to 5: 0.5-1.2, 6 to 8: 0.5-1.2, 9 to 12: 0.2-0.8, ≥13: 0.2-1.3

In addition to reduced incidence of heart attacks, moderate and moderately vigorous levels (intensities) of physical activity also protected against sudden heart attack death. However, physical activity “only at the highest levels” was associated with small, beneficial increases in high density lipoprotein cholesterol (HDL). **(op cit p 392)**

Despite this extra benefit from only vigorous activity, the authors concluded:

“Our results accord with those of Paffenbarger et al who suggested that regular frequent activity is associated with a reduced rate of heart attack....Our findings also suggest that the protective effect is not limited to those taking vigorous aerobic exercise twice weekly and we would encourage a more positive attitude to participation in regular moderate activity in all age groups.” **(op cit p 393)**

7.7.1 Summary of Shaper and Wannamethee 1991

The results presented by Shaper and Wannamethee were consistent with those of Paffenbarger to the extent that they demonstrate a clear, broadly linear association between regular moderate activity and a reduction in heart attack rates. Mindful of Morris' vigorous threshold hypothesis, the authors excluded all men from their physical activity index who reported (vigorous) exercise at least once a month and found that the inverse

association was just as strong – at least among men without existing ischaemic heart disease.

However, they also said that the inverse linear association continued up to levels of 'moderately vigorous' activity, a conclusion more in line with those of Morris and his team.

Shaper and Wannamethee appeared to cast doubt upon Paffenbarger's sheer volume hypothesis, suggesting, again like Morris, that regular walking was only significantly associated with heart attack risk at a substantial duration (41-60 min/day) and at a 'fast pace'.

Finally, their finding that risk reduction was just as strong when sporting activity was excluded, appears to sit uncomfortably with their separate conclusion that sporting exercise itself was significantly associated with a decreased risk in heart disease, although protection did not increase progressively with increased frequency.

Despite this somewhat conflicting evidence over the relative benefits of moderate versus more vigorous intensity activities, Shaper and Wannamethee appeared eager to endorse a new public health message by encouraging "a more positive attitude to participation in regular moderate activity in all age groups." **(op cit p 393)**

7.8 The Epidemiological Studies (1986-1991) Summary and Conclusion:

The 1984 physical activity workshop organised by the USDHHS Centers For Disease Control (CDC) under Kenneth Powell highlighted the obligation of interested investigators to devise and defend a public health message on physical activity. The workshop's conclusions advised and urged Americans to take up their own programmes of light to moderate physical activity to improve their health and to reduce their risk of disease and early death, primarily from coronary heart disease. Their decision to move away from the then current advice to exercise 'vigorously' appears to have been based on several inter-related factors. First, the workshop members believed that a growing body of scientific evidence, based primarily on epidemiologic studies, would determine that light to moderate physical activities, especially if adopted by sedentary people, would on an individual basis

provide greater health benefits than had been previously thought, at less risk of injury, and even sudden death than would more vigorous pursuits. Second, on a population basis, they believed that a moderate activity message was more appropriate because the majority of Americans who were reported to be sedentary, would be mostly unwilling and, indeed, often incapable of adhering to a more vigorous regime. At the time, and within the same workshop, evidence for these assertions was limited and indeed, contrary evidence on the significantly greater protective ‘heart-health’ benefits of more vigorous physical activity was reported (**Siscovick et al 1985**). Nevertheless, the workshop members clearly expected that emerging studies would verify and validate their support for a new moderate physical activity guideline and they showed particular interest in ‘walking’ as the best, cheapest and most widely available (and adoptable) public health prescription.

Looking back in 2007, Kenneth Powell agreed that there was a clear link between his workshop participants wanting physical activity to play a much greater part in US public health, and their desire, perhaps without sufficient evidence, to back a ‘moderate intensity hypothesis’:

“I think it comes out in the papers from the conference [workshop]. Yes, I’d say the thinking was already there....I was aware and was subject to the same force of community thinking that the people who wrote those [workshop] documents....I had that same feeling that look, vigorous activity, well, I love it, and I know a number of people who love it too. But I also know a number of people who won’t touch it, and they never would, and to go on simply recommending this really vigorous physical activity – if you can’t do it, there’s no sense in doing anything. I think the evidence [for moderate intensity activity] was sound for me.” (**personal communication with KE Powell, Atlanta, Georgia May 2007**).

The results from the first major longitudinal study to emerge after the 1984 workshop was the first extensive examination of all-cause mortality among the Harvard Alumni cohort by Paffenbarger and colleagues (**Paffenbarger et al 1986**). While this group saw a 21% reduction in risk of death among active walkers (≥ 9 hr/wk v ≤ 3 hr/wk), and even greater reduction (35%) was seen among men who played vigorously active sport no more than 2hrs/wk compared to none.

The next major study came from Leon and colleagues. **(Leon et al 1987)** It clearly demonstrated the benefits of heart attack reduction from moderate intensity activity (4.4 – 5.5 kcal/min), and suggested that increased fitness from more vigorous or intensive activity brought no further reduction in heart attack deaths, albeit some further reduction in non-fatal incidence.

However, application of this study's findings for public health purposes was questionable because the selected cohort's very high cardiac risk profile, and unfitness made it unrepresentative of the general population. . A third study **(Ekelund et al 1988)** which used treadmills to measure fitness, found a clear, inverse linear association between fitness level and deaths from CHD and CVD, with the fittest quartile clearly better protected than those whose fitness level was comparatively moderate.

By sharp contrast, the male and female study by Blair and colleagues **(Blair et al 1989)** which also used treadmills, overwhelmingly found the greatest reduction in all cause mortality between the cohorts most sedentary quintile and the next least fit quintile. Thereafter, improvements in death rates were only, at best, modest among the fitter and fittest quintiles. A further study from Britain **(Morris et al 1990)** broadly found once again that a vigorous threshold of aerobic exercise (7.5 kcal/min) was necessary to produce significant heart attack death reduction. However, among older men (55-64) a smaller, but still significant reduction was observed below this (intensity and frequency) threshold, and among all men in the cohort when 'duration and pace, were examined (fast walking but below 6.4 km/h) for $\geq 3\frac{1}{2}$ hrs/wk. In **Shaper and Wannamethee 1991** the evidence for heart attack death reduction broadly, but not entirely, supported Paffenbarger's finding that moderate volumes of moderate activity, without any vigorous activity, were sufficient to produce significant reductions in heart attack death rates. But some evidence was conflicting, suggesting that 'regular walking' alone was not effective unless a 'fast' pace was added to duration – a finding in common with Morris and colleagues.

An examination of all six studies reveals an inconclusive picture on the merits, in public health terms, of moderate versus vigorous leisure time physical activity. All of the studies – including, for the first time, **(Morris et al 1990)** showed significant benefits from moderate activity – where previously Morris and colleagues could find no such significant benefits among an earlier, but very similar cohort of middle aged male civil servants **(Morris et al**

1973, 1980).. However, three of the studies (**Paffenbarger et al 1986, Ekelund et al 1987 and Morris et al 1990**) found the greatest benefits from highest fitness or vigorous exercise. And to a lesser extent (**Shaper and Wannamethee 1991**) also saw increased benefit from “fast” walking while finding none from regular walking. Two studies (**Leon et al 1987 and Blair et al 1989**) indicated significant benefits from moderate fitness and activity, while seeing little or no death rate improvement from vigorous activity. However, of all the studies, the one from Blair and colleagues (**Blair et al 1989**) stood out as unique. Its cohort contained both men and women. Its method, using treadmill testing, was highly advanced and accurate in measurement of fitness. And it alone found impressive death rate reductions between effectively sedentary individuals and those who achieved very modest fitness. Little further improvement was seen from attaining greater fitness. The authors were eager to advance their results as a model for physical activity guidelines disseminated in a public health message to the American public. **(personal communication with SN Blair, London November 2004 and September 2006)**

7.9 The Intervention Studies of the Early 1990s: Cardiorespiratory fitness v Cardiovascular Health: Duncan et al 1991

The call for a new public health message which stressed moderate physical activity – as evidenced most convincingly by the epidemiologic study by Blair and colleagues in 1989 – was to be strengthened by two prominent intervention studies that were reported in the early 1990s. The first to emerge, while not co-authored by Blair, was produced by his junior colleague, John Duncan, at the Cooper Institute in Dallas Texas. Like Blair's work, it was also published in the *Journal of the American Medical Association* (**JAMA**) where it was to be widely read throughout the medical and public health communities.

Duncan and colleagues set out to determine whether the pace (speed) of walking needed to improve cardiorespiratory fitness differed significantly from the pace needed to reduce cardiovascular risk factors, particularly improvement in the 'good' HDL cholesterol levels. **(Duncan et al 1991)** The investigators wished to test whether walking at a very moderate pace might significantly increase HDL levels without necessarily causing a significant increase in cardiorespiratory fitness. They pointed out that earlier prospective clinical studies had reported inconsistent results, and four studies in particular “failed to

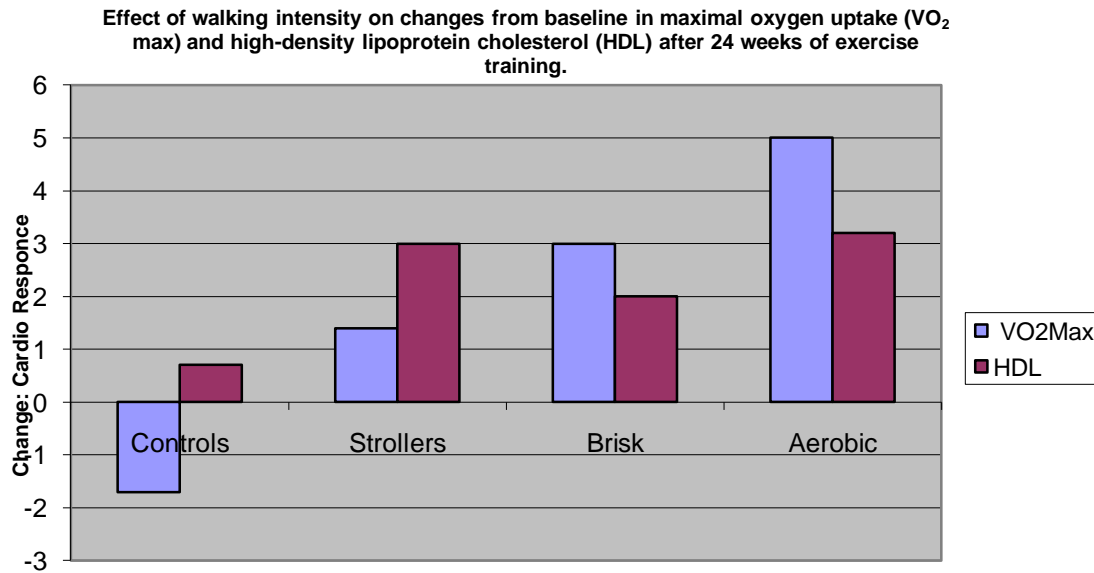
demonstrate a significant rise in HDL cholesterol concentrations after training.” (op cit **3298**). However they suggested that the earlier studies may have been too short in duration to reveal any significant changes.

Unusually, the study group in this randomised controlled, dose-response clinical trial was made up of sedentary, younger, pre-menopausal women (aged 20-40 yrs), 19% of whom were non-white. A strength of the design was that the dose or intervention (briefly explained below) lasted for 24 weeks from baseline – a long time, by the contemporary standards of similar physical activity intervention studies. A weakness of the study, however, was its size. Only 59 women completed the trial, and 13 of those were sedentary controls.

The 46 active women all walked an identical distance, 4.8 km (3 miles) for 5 days each week on a surfaced track. But they were randomly assigned to walk that same distance at three different speeds: ‘aerobic’ (8.0 km/h – 5 mph) ‘brisk’ (6.4 km/h – 4 mph) and ‘strolling’ (4.8 km/h – 3 mph). Since all the women were sedentary at baseline, the study design allowed them to attain both the distance and their allotted speed gradually over the early weeks.

Nevertheless, it seems very likely, although the authors did not comment, that the sedentary women in the ‘aerobic’, and even in the ‘brisk’ group would have found achieving their target speeds difficult. And not surprisingly, at the end of the 24 weeks the cardiorespiratory fitness (measured by maximum oxygen uptake, VO_2 max) of the three groups increased in a near-perfect linear, dose-response (by intensity of energy expenditure) manner with the aerobic walkers top.

However, when improvements in HDL cholesterol were measured the dose-response, while positive in all three groups, was not linear, with the ‘strollers’, the slowest walkers, recording increases almost as great as the fastest, and fittest ‘aerobic’ walkers. The improvement seen by the middle-speed ‘brisk’ walkers, was the smallest, but the authors suggested this result may simply have been due to the design flaw of a too small sample size ($n = 12$). The changes in VO_2 max and HDL cholesterol levels of each group of walkers are shown in **Figure 7.7**.

Figure 7.7

Source: **Duncan et al (1991)** Table 3 p 3298. Significance p for trend **VO₂ max** Controls: <.001 Strollers: <.05 Brisk: <.001 Aerobic: <.001 **HDL** Controls: not significant (ns) Strollers: <.05 Brisk: ns Aerobic: >.05

Duncan and colleagues concluded: “Our study provides clinical evidence that quantity and quality of exercise needed to decrease the risk for developing cardiovascular disease may differ substantially from what is required for improvements in cardiorespiratory fitness.” Or, put more succinctly: “Thus, our study is the first to show that within a group of healthy women the rise in HDL cholesterol, unlike the rise in fitness, is not related to intensity of exercise.” (**op cit p 3298**)

7.9.1 ‘The Public Health Perspective’

Duncan and colleagues accepted that the HDL improvements they reported were perhaps modest on an individual level, but not from a public health perspective:

“Upon initial review of our data, the magnitude of change in HDL cholesterol appears modest. However, from a public health perspective, even small improvements in coronary risk factors, if established on a population basis, could lower cardiovascular-related mortality.....Clinical data indicate every 1% rise in HDL cholesterol lowers the risk of coronary disease by as much as 3%. Thus, an important public health impact may be obtained simply by persuading

the majority of the population who are least active to become just a little more active.” **(op cit p 3299)**

Duncan and colleagues quoted a single reference for the assertion that every 1% rise in HDL decreases coronary disease by as much as 3%. The reference came, not from other physical activity intervention or epidemiological data, but from a pharmaceutical trial designed to test a cholesterol-lowering drug (statin) treatment. **(Manninen et al 1988)**

The authors then drew direct comparison and support from the work reported in the recent all-cause mortality study by their colleague Steven Blair **(Blair et al 1989)**. Duncan and colleagues observed:

“In fact, this hypothesis is supported by a recent epidemiologic report that suggests that women who regularly participate in physical activities, even at low levels, may experience lower all-cause mortality rates compared with a cohort of sedentary women.” **(Duncan et al p 3299)**

But Blair and colleagues reported only upon ‘total serum cholesterol levels’ as risk factors in all-cause mortality – not HDL cholesterol levels, so precise comparisons between the two published studies perhaps ought not to be made.

7.9.2 Adherence to Various Intensities of Exercise

In support of their findings, Duncan and colleagues also suggested, albeit without any reference or citation, that again, in public health terms, adherence to exercise diminished with increases in intensity – and hence moderate activities would be better tolerated and complied with than more intense, vigorous activity: “Low to moderate physical activities have greater compliance rates than more vigorous exercise activities, are more easily incorporated into one’s daily life-style and are well maintained over time.” **(op cit p 3299)**

However, when commenting upon adherence rates in their own 24 week study they reported: “Compliance to training (total numbers of sessions attended divided by total number of sessions possible) exceeded 85% for all three walking groups.” **(op cit p 3296)** They did not attempt to explain why ‘aerobic’ walkers were just as reliable in attendance as ‘strollers’ and ‘brisk’ walkers. Possibly, the faster walkers also found that the shorter

amount of time that they needed to complete the same 4.8 km circuit meant that their regimes more easily incorporated into their 'daily lifestyle'.

7.9.3 Other Cardiovascular Risk Factors

Duncan and colleagues measured and reported upon the other common blood risk factors (blood pressure, total cholesterol, LDL cholesterol, cholesterol and HDL ratio and triglycerides) but did not comment on these somewhat conflicting findings, even when, uncommonly, they reached statistical significance. For example, only the 12 brisk walkers (thus neither strollers nor aerobic walkers) recorded a statistically significant mean drop from baseline in their 'bad' LDL cholesterol. For reasons unexplained, only the sedentary control group recorded a mean statistically significant drop from baseline in their 'bad' triglyceride levels, whereas none of the walking groups did.

7.9.4 Summary of Duncan et al 1991

On the evidence presented, increased walking speed produced linear and steep improvements in cardiorespiratory fitness – a generally expected dose-response outcome. But the same, increasing (intensity) dose did not yield the same linear response when the observed outcome measure was switched to improved HDL cholesterol levels. Here, the slowest walkers improved almost as much as the fastest, and arguably with less apparent effort, if time spent was not a consideration.

While calling, in the normal way for further research, the authors clearly believed that their results had, in US population terms, considerable public health importance. Indeed, and with precise relevance to this dissertation, they went so far as to suggest that the then current and single government approved physical activity guideline (20 minutes vigorous activity 3 times a week) should be amended:

“In summary, our findings indicate that different walking intensities influence various aspects of cardiovascular health and fitness. This observation may serve as a basis to divide what was previously one exercise prescription into a least two – one that follows the American College of Sports Medicine’s guidelines with emphasis on fitness and one designed to enhance the lipid profile without necessarily having a major impact on fitness.....From a public

health perspective it may be more advisable to focus on encouraging the masses to participate regularly in low-level activities rather than advising a few do more vigorous exercise.” (op cit p 3299)

Duncan and colleagues did briefly mention that the small size of the sample (brisk walkers $n = 12$), may have distorted their main finding, but they did not question the validity or accuracy of their inability to see significant changes in the other blood risk factors tested and reported. Instead, they chose to focus on the study’s strength: its relatively long follow-up period of 24 weeks to explain why it had found significantly improved HDL levels when previous, shorter studies had not.

Finally, without reference or citation, the authors further suggested that light to moderate activities have better adherence rates and are well maintained over time compared to higher intensity exercise. Yet in their own study adherence rates were equally high -- above 85% for all walking intensities.

7.10 King et al 1991 and 1995: Adherence Tested as a Central Public Health Issue

The next intervention study to emerge came from William Haskell’s team at Stanford University. (King et al 1991) It too received prominent publication in *The Journal of the American Medical Association (JAMA)*.

Like Duncan and colleagues, the California team’s primary focus was also the effect of exercise intensities on cardiorespiratory fitness and on heart disease risk factors. Importantly however, they also included in their main outcome measures ‘exercise participation rates’ – a specific acknowledgement that, from a public health perspective, the effectiveness of any exercise prescription had to be judged not only by its narrow dose-response in a given individual, but also by how widely and conscientiously the dose (exercise prescription/advice) might realistically be adhered to within free living communities of ordinary people. As the King and colleagues observed:

“Exercise training studies of middle-aged and older adults that have reported substantial improvements in functional capacity of 10% to 15% or more are often far removed from the individuals and circumstances usually encountered by practicing physicians. For instance, they typically involve small numbers of

highly selected subjects followed over a relatively short time period (i.e., 6 months or less). Smokers and overweight individuals – groups known to have difficulty maintaining an exercise regimen – are often excluded. Yet, it is these individuals who have the most to gain by becoming more active....Such studies elucidate the efficacy of exercise training (i.e., what the treatment can achieve under ideal conditions), but not its effectiveness under representative conditions.” **(King et al 1991 p 1535)**

The authors therefore set out to design a study – with greater numbers, of longer duration, and in more realistic environments – to test what genuine and sustainable benefits might be achieved to the public’s health from various intensities and settings of physical activity. They explicitly set out to challenge the old tradition of organised intensive exercise training (which primarily measured improved cardiorespiratory fitness), to concentrate on more moderate, self-motivating activities which they believed free living American adults might be able to enjoy, adhere to, and still gain health benefits from:

“In practice, it is likely that the majority of middle-aged and older Americans possess neither the willingness nor the ability to exercise at the intensity or duration necessary to achieve the change in functional capacity achieved in laboratory-based training studies. However, epidemiologic evidence [they cited **Blair et al 1989** and **Ekelund et al 1988**] continues to mount that even modest increases in functional capacity resulting from light-to moderate-intensity activities substantially reduce the risk of diseases such as ischemic heart disease.” **(King et al 1991 p 1535)**. They further observed: “While class or group based training is the major type of formal exercise instruction in the United States, most Americans prefer to engage in physical activity on their own, outside a formal group structure. **(op cit pp 1535-36)**

7.10.1 Study Design

While Duncan and colleagues were able fully to recruit only 59 women, of whom 13 were controls, King and colleagues fully recruited 132 women and 168 men, of whom 29 and 45 were controls, respectively. All participants were 50-65 yrs at baseline, sedentary and free from cardiovascular disease. Smokers and ‘moderately overweight’ people were not excluded (Mean BMI: men 27.4, women 26.6), Moreover, their randomised controlled trial

was unusually long. It ran for 1 year, and then with modifications, for a second year. Finally, a key objective of the design was to compare not only intensity of activity but also the effectiveness (health outcomes and adherence) of 'group-vs home-based exercise training' – in effect, organised, gym-style training v less-structured, self-motivating home-based exercise supervised primarily by self-reported log books and infrequent telephone supervision.

There were three randomly selected exercise groups (group higher intensity, home-based higher intensity and home-based lower intensity). The higher intensity groups trained for 40 minutes, 3 times a week at 73%-88% of their peak heart rate tested by treadmill. The lower intensity group trained for 30 minutes, 5 times a week at 60%-73% of peak heart rate. The exercise ('endurance activity') for all groups was walking or jogging. Attendance was logged by an instructor at group sessions. Home-based participants logged attendance by self-report, corroborated by an 'ambulatory heart-beat recorder.' It should be noted here that the authors described this higher-intensity energy expenditure rate as comparable to 7 to 7.5 METs – an intensity level higher than the 'minimum threshold' or 'vigorous training effect' (>6 METs) first defined by Morris (**Morris et al 1973**) The lower-intensity energy expenditure was set at 4 to 4.5 METs.

7.10.2 Interpretation of Results at 1 Year

Of their three outcome measures (fitness, cardiovascular risk factors and adherence) the authors chose first to focus on adherence and to stress the effectiveness of home-based exercise training after 1 year of intervention. They noted that adherence (completed training sessions) was significantly higher for both of the two home-based groups than for the group-based trainers. "The advantages of home-based training include increased convenience, flexibility, and greater general appeal for a substantial portion of the American public." (**King et al 1991 p 1540**) The authors did not, however, express surprise or even comment upon the slightly higher (78.7%) mean adherence rate achieved by the higher-intensity home-based participants than their lower intensity home-based counterparts (75.1%) – despite their working hypothesis that the majority of middle aged Americans possessed 'neither the ability or willingness' to adhere to higher intensity activities. They chose instead to highlight the favourable (and flattering to their hypothesis) gap between home v group (freestyle v organised gym) exercise activities.

Next, the authors examined the association between adherence and fitness improvement, observing that:

“....the magnitude of improvement in VO_2 max [maximum oxygen uptake] and treadmill duration was greatest among those individuals exhibiting the highest levels of exercise adherence during the year, indicating that greater gains can be obtained if prescriptions are regularly followed.” **(op cit p 1541)**

They further observed how well the lower-intensity (moderate) participants had done. Their treadmill time and VO_2 max improvements were not significantly smaller than their higher intensity home-based counterparts:

“It is striking that exercise adherence rates and increases in fitness among subjects performing lower-intensity home-based exercise training were comparable to those of subjects performing higher-intensity training.” **(op cit p 1541).**

Discussion of the third major outcome measure: “heart disease risk factors”, was very limited across all three exercise groups, presumably because: “Significant changes in the major cardiovascular disease risk factors did not occur in the present study despite good adherence to exercise over an extended period.” **(op cit p 1541)** The authors suggested that the failure to see any significant improvement in HDL cholesterol and other blood risk factors was probably linked to the only relatively modest improvements in VO_2 max (the primary indicator of cardiorespiratory fitness) that their previously sedentary and middle aged participants were able to achieve. Nevertheless, the intervention study was extended for a second year with one major modification: the control group was dropped.

7.10.3 The Second Year of Intervention: King et al 1995

Results from the second and final year of intervention, reported in King et al 1995 revealed further important differences in the three modes of exercise – with the higher-intensity group based participants performing worst in each of the outcome measures: change in VO_2 max, adherence (participation rates), and changes in HDL cholesterol concentrations.

Examination of the two home based modes (higher-intensity, lower-intensity) proved more complicated. On two out of the three outcome measures the higher-intensity home-based

group performed better – VO_2 max and, most surprisingly, adherence -- than their lower-intensity counterparts. However, the authors chose to emphasize the perhaps equally surprising find that:

“...by the end of year 2 subjects in the two home-based training conditions showed small but significant HDL cholesterol increases over baseline ($p < .01$). The increases were particularly pronounced for subjects in the lower-intensity condition, whose exercise prescription required more frequent exercise sessions and were associated with decreases in waist-to-hip ratio in both men and women ($p < .04$).” **(op cit [online no page])**

This superior result in HDL cholesterol achieved by the lower-intensity home-based participants contrasted with their relative collapse in adherence (participation rates) during the second year. King and colleagues observed:

“The higher-intensity, home-based training condition maintained an adherence level that was relatively high (mean, 67.8 \pm 46.0%)....However, the adherence rate for the lower-intensity, home-based condition (mean, 49.0 \pm 42.7%) dropped to a level that was more similar to that for the higher-intensity group-based condition and significantly lower than that for the higher-intensity, home-based condition ” **(op cit)**

The authors attributed this disappointing result to ‘anecdotal reports from participants’ that they were finding adherence to a 5 x week regime increasingly difficult, whereas clearly this was less difficult for the higher-intensity participants who were exercising more vigorously, but less frequently at 3 x week. King and colleagues nonetheless explained the lower-intensity participants’ greater HDL cholesterol improvement on the fact that, while failing to hit the 5 x week adherence target, they nonetheless averaged more exercise sessions per week across the two year period (3.0 sessions) than did the higher-intensity participants (2.2 sessions). They explained:

“In contrast to the changes in treadmill test performance (fitness, where higher-intensity home-based did best) these results suggest that the frequency of exercise may be important in producing metabolic changes related to increases in HDL cholesterol. In contrast, a higher intensity exercise level did not appear to be essential in promoting HDL cholesterol increases in the sample.” **(op cit)**

However, in year 2, when the HDL cholesterol improvements were seen, this higher frequency of exercise would not have been maintained among the lower-intensity participants, making the apparent success of relatively infrequent and moderate activity all the more impressive in population terms.

This may explain why the authors seemed so unconcerned by the dramatic fall in adherence in year 2 among the lower-intensity participants. The frequency of the adherence dose was, based on their findings, simply too high (5 x week), and possibly, unnecessarily high. For they then narrowed their inquiry to examine the HDL cholesterol levels only of participants in all three sub groups who managed 2 or more exercise sessions a week on average during the 2 year period. Regardless of exercise intensity or method, participants meeting this target showed a mean measurable improvement in their HDL cholesterol levels. And finally, over half (51.7%) of participants in the lower-intensity, home-based condition had an increase of 5 mg/dL in HDL cholesterol compared with a third or less in the higher-intensity, home-based and group-based conditions (35.2% and 32.0%) respectively. **(op cit)**

The evidence in favour of modest amounts of moderate activity, while taking a long time to appear, seemed impressive – at least by the single measure of HDL cholesterol. The authors said:

“While subjects in the lower-intensity, home-based exercise condition were able to achieve these increases by engaging in approximately 30 minutes of brisk walking about three times per week – levels of physical activity that should be quite feasible for the majority of the American public to attain – the fact that a 2-year period of such physical activity increases was required to achieve these HDL increments is sobering.” The authors concluded: “The suggestion that a longer time frame and reasonable frequency of ongoing exercise participation may be required to achieve HDL cholesterol increases in older adults underscores the importance of physical activity regimens that are convenient and enjoyable enough to be adequately sustained over time.” **(op cit)**

7.10.4 Summary of the Intervention Studies: Duncan et al 1991, King et al 1991, 1995

Taken together, the intervention studies in the early 1990s by Duncan et al and King et al appeared to support the conclusion that higher-intensity, or vigorous physical activity was superior in promoting cardiorespiratory fitness – a significant risk reduction factor in heart disease. Surprisingly, given the authors' assumptions that middle aged, previously sedentary Americans were unwilling, or indeed unable, to perform and then adhere to a vigorous exercise programme, adherence to higher-intensity activities was remarkably high, except among the group based participants in the King et al studies. Indeed adherence to vigorous activity was significantly higher than moderate activity among participants in home environments – an outcome clearly unexpected by the authors.

Nevertheless, the authors of both studies emphasised the importance of finding that significant improvements in HDL cholesterol – another important risk reduction factor in cardiovascular disease -- could be achieved without strenuous effort by previously sedentary Americans who were willing to perform activities of only moderate intensity. King et al noted, however, that a frequency rate of 5 x week was not well maintained over time even when only moderate activity was required. Unfortunately, the design of the study did not include a 5 x week higher-intensity group whereby both adherence rates and HDL cholesterol improvements between the different intensities might have been more accurately compared.

It should be noted that neither team of investigators reported upon conflicting epidemiologic data which asserted either that: Improved HDL cholesterol levels occurred with a linear increase in treadmill fitness (**Blair et al 1983**) or that vigorous intensity activity showed greater improvement to HDL cholesterol levels than mere volume of moderate activity. (**Folsom et al 1985**).

7.11 Chapter 7 Summary

This chapter has shown that the large longitudinal epidemiological studies and intervention trials of the later 1980s and early 1990s focused their investigations upon the importance of 'relative intensity' of physical activity in beneficially preventing or reducing cardiovascular disease, some of its major risk factors and, in some cases, all-cause mortality. Some studies (**Leon et al 1987, Blair et al 1989**) appeared to demonstrate

remarkable benefits from relatively moderate amounts (kcal/wk) of moderate intensity activity. Others, however, (**Ekelund et al 1988, Morris et al 1990**) appeared, primarily, to demonstrate the superiority of more vigorously intense or 'strenuous' activities, although Morris did succeed in finding some common ground between the competing hypotheses. Further, some other studies, were inconclusive, or showed mixed results in these comparisons (**Paffenbarger et al 1986, Slattery and Jacobs 1988, Slattery et al 1989, Shaper and Wannamethee 1991**). Further, the two long term (6-24 months) intervention studies under the direction of Haskell and Blair, respectively (**Duncan et al 1991, King et al 1991, 1995**), openly sought to prove the benefits of moderate intensity activity (in HDL cholesterol levels and adherence to exercise). Once again the results were mixed, with unexpectedly high adherence rates by those participating in some more vigorous intensity activities. All of these investigations would pave the way for the wider public health debate on physical activity public health guidelines that preceded the US Surgeon General's 1996 Report. These debates, in the form of reviews, workshops, position papers and policy statements by learned bodies are examined next in the following chapter.

Chapter 8: The Public Health Debate 1992-1996

8 Introduction

This chapter begins with examination of three polemical essays published between 1992 and 1994 by Morris, Blair and Paffenbarger, and Powell and Blair which attempted to promote their practical visions for physical activity in a prominent role within public health policy. Once again, the question of intensity – moderate versus more vigorous activity – was at the heart of the debate about public health guidelines. The issue is also examined in two further epidemiological findings by Paffenbarger and colleagues which focused acutely on the comparative intensities of leisure time activities. Study then turns to numerous conferences, workshops and ‘position statements’ on physical activity and heart disease which began to emerge from the American Heart Association, the American College for Sports Medicine and from the US government health departments (Centers for Disease Control and National Institutes of Health) which laid the groundwork (both polemical and evidential) for the 1996 US Surgeon General's Report on Physical Activity and Health.

8.1 Morris JN 1992: *Exercise Versus Heart Attack: History of a Hypothesis*

By the early 1990s the importance of examining physical activity primarily from a public health perspective (as opposed to the science of exercise physiology) had become paramount for the leading investigators, and most notably for Morris in Britain and Blair, Paffenbarger and Powell in the United States.

In 1992 Morris (**Morris JN 1992**) sought to re-examine the recent epidemiological studies in an apparent continued search, either to find a consensus between, or at least an explanation for, the clear theoretical clash between his ‘minimum vigorous intensity threshold’ hypothesis and the alternative approach: that the accumulation of moderate amounts of moderate intensity activity without a precise minimum threshold was also effective in reducing the risks from CHD (the ‘moderate volume hypothesis’) put forward most forcefully by Blair, with some support from Paffenbarger. Morris put the argument thus in his 1992 essay, *Exercise Versus Heart Attack: History of a Hypothesis*:

“The indication that a threshold of intensity of exercise has to be reached for protection against CHD, and the further suggestion that vigorous

aerobic exercise is distinctly effectual, raised questions for theory and for public health.” (op cit p 244)

Morris’ prescription required an intensity:

“...entailing over 50-60 per cent of individual maximal aerobic power [VO_2 max], and of sufficient quantity [duration], to produce ‘overload’ and a training stimulus....Plainly, health education messages would be affected if such a proposition superseded that of the benefits of high total physical activity levels.” (op cit p 244)

Morris’ use above of the word “superseded” seems perverse since the prevailing public health prescription in 1992 continued to recommend 20 minutes of vigorous intensity activity, 3 times a week. Still, he proposed to seek a “fresh hypothesis” (op cit p 244) by re-examining his 1990 study (Morris et al 1990) with renewed focus on whether ‘high total physical activity levels’ alone could produce a reduction in CHD deaths.

As predicted, men in the 1990 study (classed as ‘group 1’) who took frequent vigorous aerobic activity were significantly protected. He again found significant protection for those (‘group 2’) who took either less frequent vigorous aerobic activity, or somewhat less intense (‘fairly brisk walks’) activities on a frequent basis – but only among older men (aged 55-64). (Morris JN 1992 p 245) This finding was consistent, Morris said, with the ageing process: “the reduction with age of the oxygen utilization capacity of muscles...so that less exercise is required for overload and a training stimulus (though of course it still has to be more intense than customary).” (op cit p 247) Going even further, Morris was able also to see “a non-significant continuation of the favourable trend in the older men” who (‘group 3’) engaged in “residual” vigorous activity and/or “shorter, fairly brisk walks.” (op cit p 247)

In this search for consensus Morris appeared to modify his strict ‘minimum threshold’ theory – at least for older men: “Thus there was some indication of dose-response of CHD with frequency/intensity in vigorous aerobic exercise.”(op cit p 247) In other words, a new interpretation of the British data might be legitimately found which did show at least some inverse linear association (as distinct from an absolute threshold) between more moderate amounts and intensities of physical activity and CHD deaths – at least among older men.

However, this observation was far from a complete refutation in favour of the total volume hypothesis of Blair, and to a lesser extent, of Paffenbarger. Morris then re-

examined the data from his men ('group 4') who reported no vigorous expenditure in their total reported 'volume' of leisure physical activities (including ballroom dancing, golf, long walks and do-it-yourself work) and who comprised more than half of his cohort. He explained the importance of this scrutiny and its negative conclusion:

"Because of the popularity and appeal of the non-vigorous sports and games, they were subjected to an intensive study, searching for example for possible associations with CHD in vulnerable groups such as cigarette smokers, the overweight, those with subclinical CVD, and so on, which might be expected to show a response to such exercise of lower intensity. Again none was found." **(op cit p 247)**

8.1.1 Cohort Differences

So, how might the differences between the 'threshold' and 'total volume' theories be explained, given that both were supported by studies benefiting from lengthy and thorough examination of substantial populations? Were there possibly significant differences between the populations themselves? Morris said:

"There are difficulties in interpreting discrepancies between the findings of these studies. Thus, in contrast with our findings, Paffenbarger et al (1978) report substantial benefit from more than 2000 kcal per week of leisure time activity, however this is accomplished. On analysis, two-thirds of the men with such high totals engaged in vigorous sports, but those reporting other non-vigorous aerobic exercise also show some, albeit less, advantage. Could it be that the American cohort is basically less active and less fit than the British and thus capable of benefiting from less intense exercise? (The same point has previously been made on age.) Other obvious differences in the populations are that the British are subject to governmental medical recruitment and retirement policies, and that they are men in post and hence are a 'healthy worker' cohort. Comparative physiological studies on American and British men could be rewarding." **(op cit p 249).**

Morris also questioned again whether his British cohort was also made healthier – and thus less visibly benefiting from less intense exercise – because of their overwhelming habit for frequent gardening and heavy garden work (90% and 80% reporting, respectively). **(op cit p 249, and personal communication with JN Morris, London December 2006)** He may have assumed that Paffenbarger's Harvard alumni would have employed gardeners, or at least would have purchased motorised mowers, hedge

cutters and other labour-saving (physical activity reducing) devices – unavailable to, or at least unaffordable for, the far less affluent British men.

In any event, Morris offered a *RESTATEMENT OF HYPOTHESIS*:

“Adequate aerobic exercise in leisure time, which is habitual and ongoing, and the training and improved cardiorespiratory fitness and performance this produces, confer substantial protection against the occurrence of CHD in middle-aged and elderly men.....In this statement ‘adequate’ refers to both vigour (intensity) and quantity (frequency/duration) of exercise. The hypothesis refers to ordinary relatively healthy men engaged in sedentary and physically light occupations, and not to athletes.” **(op cit p 251)**

However, this “restatement” appears, on closer inspection, to have been a further compromise or search for consensus because, in 1980, Morris had been even more hard-line in his definition: “ ‘Adequate’ exercise means vigorous exercise....above the intensity required for a training effect.” **(Morris et al 1980 p 1210)**

And Morris concluded: *FROM AETIOLOGY TO PUBLIC HEALTH*

“There is now good reason to believe that the decline of physical activity in work, recreation, transport, and daily living is an integral part of the modern epidemic of CHD in developed industrial societies. This decline may well have been greatest in adequate aerobic exercise, and hence in cardiorespiratory fitness.” **(Morris JN p 251-52)**

He continued:

“Exercise is today’s best buy in public health, not only because of the need and potential, but because it is positive and acceptable, has insignificant side-effects, and can be inexpensive. Also, the opposition to be overcome is feeble in comparison with the tobacco barons and the Common Agricultural Policy for instance.” **(op cit p 252)**

Finally, Morris noted the narrow, middle-to-upper-middle class bias of his and other studies:

“Only a minority of the population takes anything worthy of the name of exercise, and only a small minority of the lower social classes that are most vulnerable to heart attack.....aetiological studies are urgently required in other social and occupational samples, particularly among the lower socio-

economic groups, to aid formulation of population strategy.” (op cit p 252-53)

8.1.2 Summary of Morris JN 1992

Morris re-analysed his British civil servant data in an effort to re-test his ‘vigorous threshold’ hypothesis, evidently striving to find some scientific common ground with investigators such as Blair and Paffenbarger who continued to support the opposing ‘total volume’ of physical activity approach. As he made clear, Morris was driven by his belief that ‘exercise is today’s best buy in public health’ and was eager to see that appropriate physical activity strategies and guidelines be implemented to halt, or at least control the heart disease ‘epidemic’ that was fast growing in industrial, and increasingly sedentary societies, like Britain and the United States.

Meanwhile, Blair and Paffenbarger, were similarly engaged in their own public health assessment of physical activity and what best prescription(s) might be offered to the general public.

8.2 Blair et al 1992: *How Much Physical Activity is Good for Health?*

While Morris continued to assert that his was the ‘alternative’ minimum threshold hypothesis, Blair and Paffenbarger (and two other colleagues) took the opposite view, indirectly alluding, but with clear reference, to the seminal work of Morris himself (**i.e. Morris et al 1953, 1973**): In their rival essay, *How Much Physical Activity is Good for Health?*, Blair and Paffenbarger (**Blair et al 1992**) observed:

“For the past several decades, the generally held view is that there is a minimum exercise intensity required to stimulate an improvement in physical fitness....An alternate hypothesis to a threshold level of intensity is that the response to exercise training is primarily, if not exclusively, dependent upon the total energy expended in exercise and not intensity.” (**Blair et al 1992 p 102**)

The authors next appeared to make a controversial claim: that low intensity physical activity – if ‘sustained longer’ – could achieve identical increases in aerobic power (maximal oxygen uptake or VO₂ max) compared with high intensity activity. This would be an important claim since it was Morris’ assertion that threshold intensity was the prime factor inducing this ‘training effect’ on the heart which brought increased

cardiorespiratory fitness – and thus aerobic power. Previously, advocates of moderate physical activity had more modestly suggested that it would bring “somewhat similar” improvements in fitness and reduce coronary risk factors, without such an absolute comparative assertion. **(Haskell et al 1985 p 207)** Blair and Paffenbarger observed:

“There is an interrelationship between intensity and duration in their impact on fitness change. Low intensity activity must be sustained longer than high intensity activity to have the same effect on improvement in aerobic power. Again, the total energy expenditure of the exercise session is likely the critical factor for fitness change.” **(Blair et al 1992 p 102) (emphasis added)**

In simple terms, the authors were claiming, for example, that a one hour, moderate daily walk at, say, 3 mph (4.8 km/h) each day would typically improve cardiorespiratory fitness in an individual by the **same** amount as a 20 minute jog/run each day because duration and intensity were effectively inter-changeable.

Yet, when examining the role of exercise intensity in improving HDL cholesterol serum levels (an important cardiac risk reducer) the authors said that “both the intensity of exercise and total quantity of weekly expenditure” were responsible. **(op cit p 105)**

8.2.1 Physical Activity Guidelines Directly Examined and Questioned

Blair and Paffenbarger directly challenged both the scientific validity, and the social implications of the US Department of Health’s advocacy of vigorous activity in the then current physical activity guidelines which they cited as: **(American College of Sports Medicine 1991, 1986, 1975 and American College of Sports Medicine Position Stand 1990)**

“The exercise prescription emphasizes relatively vigorous, large muscle activity for at least 20 minutes at a minimum of three times per week. This dose of exercise was adopted by the Surgeon General of the United States for the 1990 health objectives. Many public education campaigns, books, and articles have presented the exercise prescription approach as advice to the public.” **(Blair et al p 115)**

The authors effectively announced their firm belief that the Surgeon General’s ‘vigorous activity’ guidance was inherently ill judged. Indeed it was, they argued, injurious to the public health, because its effect in dissemination was to discourage people from taking

moderate amounts of healthy moderate physical activity - thus leading to a continuation of disease-inducing sedentary inactivity amongst the American population:

“We believe that these activities have led both the public and health professionals to adopt a dichotomous view of exercise. That is, unless a person achieves the specified exercise prescription, there are no benefits or responses to the training program. In our opinion, this is an incorrect view, especially in terms of the health effects of physical activity. (op cit p 115)

The use of the idea incorrect ‘dichotomous view’ – that advocacy of vigorous activity might actually cause public ‘misperception’ that moderate intensity exercise was not worth pursuing – was to re-emerge under the aegis of two highly influential bodies during the final preparatory stages of the US Surgeon General’s 1996 report. (see Pate et al 1995 p 404 and NIH 1996 p 243)

In evidence, Blair and Paffenbarger presented two graphics (**Figure 8.1 and Figure 8.2**) to support their hypothesis that a vigorous activity threshold was unrealistic, and unnecessary. In addition, they asserted that the association between physical inactivity and cardiac risk was not only linear (‘a gradient of risk’) – but that it was, in population terms, more accurately concave curvilinear in shape with the greatest health benefits observed at the lowest end of the spectrum when sedentary people moved to and sustained modest amounts of moderate intensity physical activity to achieve a relatively small increase in cardiorespiratory fitness. Activity above and beyond this exertion (either in intensity or duration) delivered either only relatively modest improvements, and could, in the extreme, actually increase mortality.

The authors also presented a composite graph (not shown here) which portrayed, in histograms, the associations between physical activity/fitness and cardiac/all cause mortality as described in five of the recent epidemiologic studies (including their own) and already discussed (and displayed graphically) with the exception of **Leon et al 1987** in this dissertation. (**Paffenbarger et al 1986, Leon et al 1987, Ekelund et al 1988, Blair et al 1989 and Morris et al 1990**). It may be important to note the word ‘constructed’ in the explanatory legend of the composite graph when Blair and Paffenbarger noted that: “The figure is constructed from data taken from five prospective epidemiological studies.” (**Blair et al 1992 legend Fig 1 p 116**). While this ‘construction’ would appear accurately to have reflected the results and conclusions of

four of the studies, it does not appear accurately and fully to have represented the results and conclusions of **Morris et al 1990**.

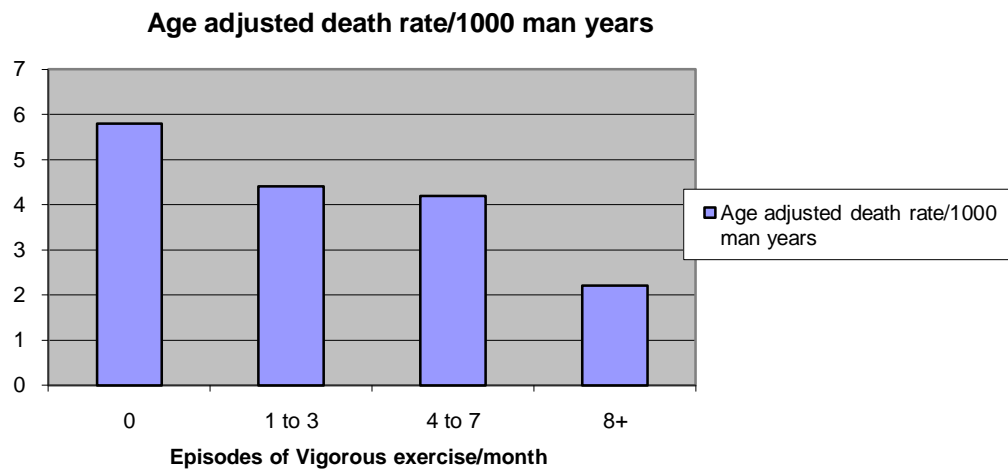
This would appear both important and anomalous. As was shown in the previous chapter (Chapter 7 Figure 7.4) Morris quite directly compared the significantly fewer coronary attacks among men with increasing monthly episodes of vigorous sports against those with increasing monthly episodes of non-vigorous sports and specifically observed that: “The contrast between...is plain, corroborating the hypothesis of a threshold of intensity for effectual exercise.” (**Morris et al 1990 p 327**) Unfortunately, however, Blair and Paffenbarger omitted to display that ‘contrast’. Instead they reproduced only the vigorous sports data from Morris’ table, which may have given the impression that Morris’ data supported their own conclusions. For Blair and Paffenbarger observed:

“These studies indicate that there is a gradient of risk across activity or fitness levels and that moderate levels of activity or fitness are associated with important and clinically significant reductions in risk. This observation opposes the widely believed threshold concept, which asserts that there is no benefit from physical activity until the exercise prescription level is reached and there are further improvements across higher levels of exercise” (**Blair et al 1992 p 115**)

But their depiction (**Figure 8.1**) of Morris’ results within their composite graph simply excluded his data (showing no significant response from non-vigorous sports) leaving the inaccurate impression that Morris’ data, showing a decreasing gradient of risk only with greater frequency of vigorous activity, somehow supported their argument:

Figure 8.1

Selective Data Reproduced from Morris et al 1990



Source: Data selectively extracted from **Morris et al (1990)** Table 1 p 326, and reproduced in **Blair et al (1992)** Figure 1 p 116

Therefore, the authors' claim that all five studies entirely supported their assertion (gradient of risk reduction through moderate 'levels' of fitness or activity) is not entirely borne out by the findings of the studies themselves. While Morris was alone in seeing a 'vigorous intensity threshold' – at least among the younger members of his cohort – only one of the other studies (Leon) supported the reverse concept (favoured most strongly by Blair) that increasing intensity of activity beyond very modest or moderate fitness brings very little health benefit.

Thus Blair and colleagues reproduced only the portion of Morris' data set which appeared, superficially at least, to support their argument – apparently choosing to ignore, and indeed failing fairly to replicate Morris' data, which showed no significant decline in heart attack deaths among all the men in his study who took no bouts of vigorous activity. They simply vanished from the diagram.

Similarly, the results of Haskell and his team (**Ekelund et al 1988**) did support a linear dose response gradient – but they certainly did not strongly support Blair's moderate levels of moderate activity hypothesis. The gradient, as reproduced by Blair and Paffenbarger, examined the incidence of cardiac deaths over time by relative levels of fitness measured by treadmill test, and Ekelund and colleagues' definition of physical activity was 'strenuous exercise or hard physical labour'. Further, Ekelund and colleagues found that 49% of the fittest and best protected quartile reported regular

strenuous activity whereas 19% did so in the least fit quartile. Most importantly, they reported the steepest fall in mortality at the fittest end of their spectrum – that is between the 2nd most fit quartile and the fittest quartile – a further indicator of the importance of strenuous (vigorous) activity, and a result at odds with that reported by Blair and colleagues: namely that the steepest fall in mortality could be seen between the least fit and next least fit sub-sets (quartiles) of his cohort. **(Blair et al 1989)**

The all-cause mortality data presented from Paffenbarger's study **(Paffenbarger et al 1986)** does accurately reflect a gradient of reduced risk with increasing total volumes of physical activity up to a plateau of approximately 3000 kcal/wk and then with a significant increase in risk at ≥ 3500 kcal/wk.

But 3000 kcal/wk cannot be realistically considered to be a 'moderate' amount of weekly physical activity when the prevailing US Department of Health's physical activity guidelines (20 min vigorous x 3) yielded energy expenditure of just one third of that total (1000 kcal/wk) – as did the moderate guidelines (30 moderate x 5) which were to replace them.

Furthermore, the 'physical activity index' reproduced by Blair and Paffenbarger included significant amounts of vigorous activity. And while Paffenbarger and his colleagues reported a 21% risk reduction among individuals who walked 9 miles per week (as compared to none) they also found a higher risk reduction (35%) among men who played vigorous sports 1-2 hr/wk (again compared to none).

Thus, only two of the five studies **(Leon et al 1987 and Blair et al 1989)** fully supported the assertion by Blair and Paffenbarger **(Blair et al 1992)** that a clear gradient of risk reduction is associated with modest increases to moderate amounts of moderate intensity activity. And, as discussed previously, one of these studies **(Leon et al 1987)** is of questionable value as a public health model population since its cohort was selected to be among the top 10%-15% of the US population with high risk characteristics for heart disease..

Therefore, it could be argued that only the data from **Blair et al 1989** entirely reflected the twin assertions made by Blair and Paffenbarger. And yet, from their analysis they concluded that:

“The dose-response relationship indicated by the five studies is good news for sedentary individuals. They can hope that a moderate physical activity program is likely to yield some important health benefits. The public health

message should be 'Doing some physical activity is better than doing none at all.' That is, a little is better than none, and, to a degree, more is better than less." (Blair et al 1992 p 115)

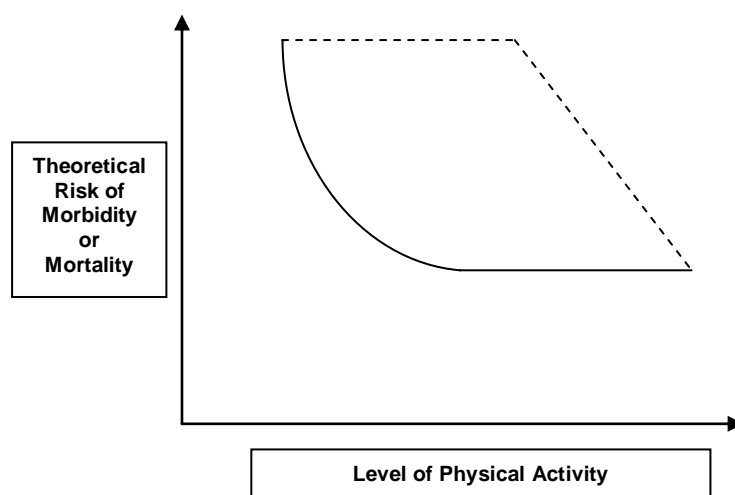
While this may have been, and may remain, good medical advice in public health terms, it was far from fully supported, as claimed, by thorough analysis of the scientific evidence presented.

However, Blair and Paffenbarger went further to underline their 'moderate level' public health message (presumably moderate amounts of moderate intensity physical activity). They produced (**Figure 8.2**) what they described as an 'idealized benefit curve (solid line)' drawn to show how easily mortality risk could be reduced by following their public health prescription. On to this curvilinear representation, they imposed a 'second hypothetical curve (dotted line)' which, they said: "probably represents the prevailing opinion of the public and health professionals" (**op cit p 115**) --- showing no benefit whatsoever from increasing physical activity or fitness until a fairly demanding 'threshold' was achieved:

Figure 8.2

Untitled Diagram from Blair et al 1992

Source: Blair et al (1992) Figure 2 p 117



8.2.2 A New 'Moderate' Public Health Physical Activity Guideline is Proposed

Like some other investigators, Blair and Paffenbarger expressed concern that the 'population attributable risk' from inactivity in the United States was so high because so many Americans (25% men 30% women) were classed as sedentary by the 1985 National Health Interview Survey, compared with only 8% of men and 7% of women reporting full adherence to the existing public health guidelines (20min vigorous x 3/wk). They observed:

"Inactivity in the US appears to be a public health problem that is of comparable magnitude to cigarette smoking, obesity, high blood pressure, and high blood cholesterol levels." **(Blair et al 1992 p 120)**

They accepted that further research would be needed to establish the dose-response effects of various physical activities on specific and separate health conditions and particularly, "the role (if any) of intensity of effort." **(op cit p 120)**

Nevertheless, and despite these important knowledge gaps, Blair and Paffenbarger proposed a profound change to the existing 'vigorous' intensity public health guidelines and aimed them firmly at the large proportion of sedentary Americans:

"The epidemiological studies suggest a linear dose-response relationship, at least up to a point, between physical activity and health and functional effects. These data support public health recommendations directed toward the most sedentary and unfit stratum of the population and emphasize doing at least moderate physical activity. If this group of adults would accumulate 30 minutes of walking per day (or the equivalent energy expenditure in other activities), they would receive clinically significant health benefits....The key factor is total energy expenditure; if that is constant, improvements in fitness and health will be comparable." **(op cit p 120)**

8.3 Powell and Blair 1994: Population Attributable Risk Further Explored

The growing public health assumption in the United States that 'moderate' physical activity should be primarily promoted was further supported when Blair and Powell worked together to publish their personal estimate of the 'population attributable risk' caused by physical inactivity ('sedentary living') among the US population: *The Public Health Burdens of Sedentary Living Habits: Theoretical but Realistic Estimates*. They wrote: "Using the epidemiologic construct of population attributable risk (PAR), we

estimate the number of deaths due to coronary heart disease (CHD), colon cancer, and diabetes that are caused by insufficient physical activity.” ((**Powell and Blair 1994 p 851**)

The authors accepted that the appropriate intensity, frequency, duration and/or type of any activity prescription would depend upon the health outcome (disease or condition) from which risk reduction was sought. (**op cit p 853 and p 855**). But their prime focus was on the overwhelming majority of adult Americans (78%) who were designated by the US Public Health Service in 1991 as either entirely sedentary, or only irregularly active and thus failing to meet either the ‘regular’ standard of 5x30 min/wk moderate activity, or the ‘vigorous’ standard of 3x20 min/wk of vigorous activity: (**US Department of Health and Human Services. Public Health Service *Healthy People 2000*, 1991 update**). It should be noted that this incorporation in 1991 of a ‘regular’ standard, alongside the existing ‘vigorous’ advice, appears to be the first official recognition by the US Department of Health, that a moderate intensity and volume guideline should be included in its public health information.

Powell and Blair constructed a theoretical table (**Table 8.1**) in which they compared the relative risk of death from three diseases (coronary heart disease, colon cancer and type 2 diabetes) between segments (‘exposure groups’) of the US population which they categorised as: sedentary; irregularly active at moderate intensity; regularly active at moderate intensity, and regularly active at vigorous intensity.

Table 8.1

Estimation by Powell and Blair of the Population Attributable Risk of Sedentary Living for Mortality from CHD, Colon Cancer and Diabetes among US Adults: Based on Activity Estimates by the US Public Health Service

		CHD		Colon Cancer		Diabetes	
Exposure Groups	P (%)	RR	PAR	RR	PAR	RR	PAR
Sedentary	24%	2.0	16%	1.8	13%	1.8	12%
Irregular	54%	1.5	18%	1.5	18%	1.6	21%
Regular	10%	1.1	1%	1.1	1%	1.3	2%
Vigorous	12%	1.0	--	1.0	--	1.0	--
			35%		32%		35%

P(%) = percentage/population

RR = Relative Risk

PAR = Population Attributable Risk

Source: **Powell and Blair 1994** Table 3 p 853

Powell and Blair, using US Public Health Service data, estimated that in 1988 some 35% of all CHD deaths (and 32% of colon cancer and 35% of diabetes deaths) would not have occurred if all American adults had been vigorously active. **(op cit p 854)**

It is important to note that the authors considered that 12% of American adults were then currently vigorously active (by the standard definition) whereas fewer, only 10%, were regularly active by the standard 'moderate' definition. This calculation assumed that all the vigorously active were also meeting the standard of regular activity, but their numbers were not included in that category. **(op cit p 853 and personal communication with KE Powell, Atlanta, Georgia May 2007)** This would suggest that the true number of adult Americans taking vigorous leisure time activity was therefore actually greater than the number engaged in moderate intensity activities – despite the common assertion then, and now, that public health messages should stress moderate intensity activities not least because they are more popular, and more likely to be adhered to than more intense vigorous activities that deter many people.

Second, the authors stated that their estimates of the relative risk score for each 'exposure group' were based upon a single paper for each disease, selected from the scientific literature. "Empirically determined RRs [relative risks] for these categories of physical activity are not available. The 'true' value of the RR for different 'doses' of physical activity is, of course, being debated." **(op cit p 853)** Thus their decision, in the

cases of CHD and colon cancer, to assign only slightly higher relative risk scores (1.1) to 'regular' adherers than to the referent (1.0) 'vigorous' group may have been arbitrary and therefore entirely open to conjecture and interpretation. Indeed, less than two years later, when Powell presented a similar paper to the National Institutes of Health Consensus Conference on physical activity and Cardiovascular Disease, he reduced the value of 'regular' (moderate) intensity activity by increasing its relative risk score to 1.2 for CHD (**Powell KE 1995 p 34: US FOIA NHLBI request data 11/08/95 bundle**)

This close coupling of the two intensities is important since it implied that urging all in the moderate 'regular' group to 'move up' to the 'vigorous' category would spare very few lives and would be inefficient and thus inappropriate advice as a public health initiative.

The authors did note some evidence that leisure time physical activity may have been rising -- at least among higher socio-economic groups such as Harvard alumni -- and more generally, perhaps in the previous 2 or 3 decades when levels of manual work were in steep decline. (**Powell and Blair 1994 p 854**) Nevertheless, Powell and Blair pointed out that the biggest reduction in attributable deaths from all three diseases would be achieved if the 'irregular activity' group, which accounted theoretically for more than half of the preventable deaths, could be persuaded to take up frequent vigorous activity. However, the authors' view was more realistically -- that the public health outcome would be virtually as good if the 'irregulars' could just be persuaded to become 'regulars', improving their frequency of activity without having the added task of increasing their intensity of effort. The same logic of attributable risk applied to the sedentary group. Powell and Blair argued:

"Given the assumptions we have made, the largest contribution to mortality reduction arises from the group who are currently irregularly active. Increased physical activity in that group brings about the largest reduction in mortality because the group is large and because the difference in RR between irregularly active and regularly active is relatively large. Large contributions to mortality reduction also arise from the sedentary group. The smallest contribution originates from the group that is regularly active because the regularly active portion of the population is relatively small and because the difference in RR between the regularly active and vigorously active is small." (**op cit p 855**)

But again, the authors offered no further evidence to justify their assertion that this relative risk difference was small between the moderate 'regularly active' and the 'vigorously active'. By way of example, Powell and Blair calculated that among the total of 509,592 deaths in the United States from coronary heart disease in 1988, some 36,200 would have been avoided if just half of the 'irregulars' had become 'regular' in their leisure time physical activity – or 7.1% of total CHD mortality. By the same arithmetic, approximately 20,000 lives would have been spared if half of the 'sedentary' had become even 'irregular' – another substantial public health achievement. But convincing half of the 'regulars' to become 'vigorous' would have saved a mere 1,600 lives – a still valuable, but comparatively modest public health achievement – just 0.3% of total CHD mortality. **(op cit p 855)**

It should be stressed again, however, that the ranking of regular moderate activity as nearly as valuable as vigorous activity (RR 1.1 versus 1.0) was decided as an 'estimate' by the authors based on the single cited reference they chose for each disease category. Such an estimate was certainly at odds with the published epidemiological work of Morris **(Morris et al 1973, 1980 and 1990)** and not entirely consistent with the work of Paffenbarger **(Paffenbarger et al 1978 and 1986)**.

8.4 Paffenbarger et al 1993: 'Moderately Vigorous' Activity Examined

When Paffenbarger and his colleagues returned to their *Harvard Alumni Study* in 1993 they apparently chose exclusively to test the new 'moderate intensity hypothesis' when considering the importance of taking up leisure time physical activity (LTPA) in reducing all-cause mortality risk. (Their examinations of other 'lifestyle choices' in the paper (cigarette smoking cessation, blood pressure and body weight changes) are not relevant to this discussion.)

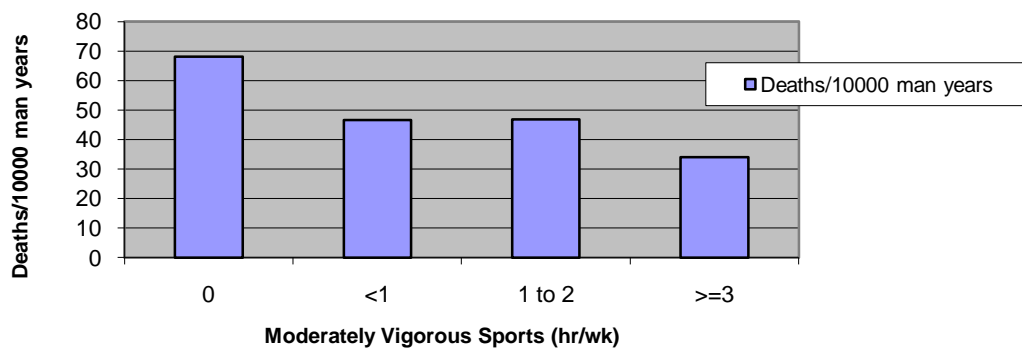
In their previous examination of their Harvard cohort Paffenbarger and his team chose to examine sports activities as light (5 kcals/min), mixed (7.5 kcals/min), or vigorous (10 kcals/min) – thus ensuring that a clear distinction was seen between the benefits of moderate, vigorous and very vigorous activities. **(Paffenbarger et al 1986 p 605)**.

This time, however, they chose to adopt just two: light (<4.5 METs) and 'moderately vigorous' (≥4.5 METs) intensities.

Nevertheless, quite substantial reductions in mortality were seen (**Figure 8.3**) in men who reported even quite modest amounts (<1hr/wk) of these 'moderately vigorous' activities:

Figure 8.3

Age Adjusted Rates and Relative Risks of Death from All Causes among 10,269 Harvard Alumni from 1977 through 1985 According to Patterns of Physical Activity

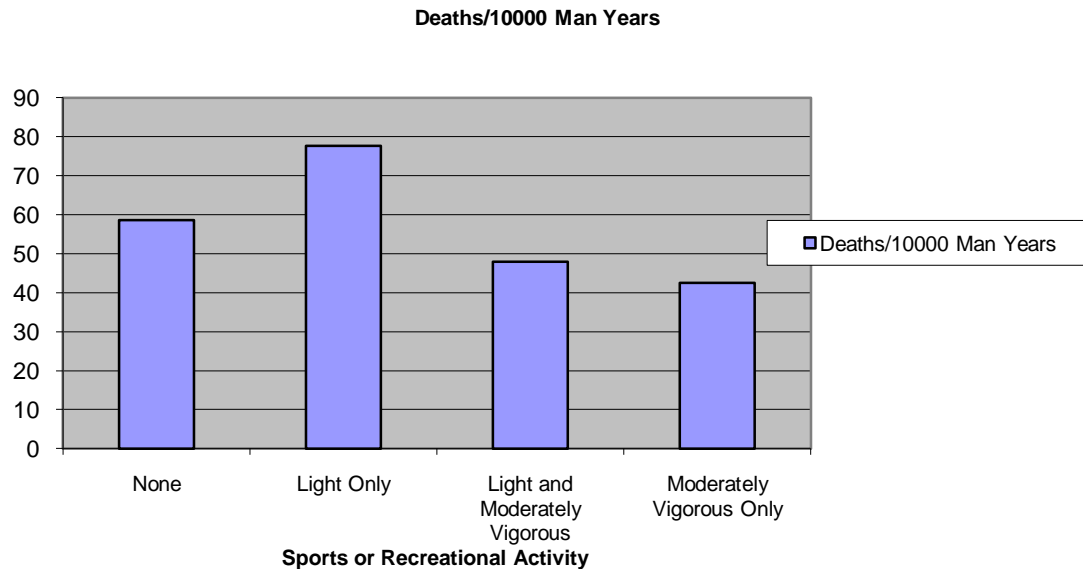


Source: **Paffenbarger et al (1993)** Table 1 p 540. Relative Risk of Death (with 95% confidence intervals: 0 hrs/wk 1.00 (referent), <1 hr/wk .68 (0.47-0.87), 1 to 2 hrs/wk .69 (0.51-0.88), ≥ 3 hrs/wk .50 (0.35-0.71)

Furthermore, a similar trend was seen (**Figure 8.4**) when relative intensities of activities, rather than duration, were compared. Indeed, 'light' activities (<4.5 METs) showed no protective effect when compared to 'none' (referent), and even appeared to increase risk. By contrast, a significant risk reduction was seen among men who practiced light and moderately vigorous activities (0.82) – but there was relatively modest further reduction seen in those who practiced moderately vigorous alone (0.73).

Figure 8.4

Age Adjusted Rates and Relative Risks of Death from All Causes among 10,269 Harvard Alumni from 1977 through 1985 According to Pattern of Physical Activity



Source: **Paffenbarger et al (1993)** Table 1 p 540 Relative Risk of Death with 95% confidence intervals: None 1.00 (referent), Light Only 1.33 (0.98-1.75), Light and Moderately Vigorous 0.82 (0.62-1.08), Moderately Vigorous Only 0.73 (0.52-0.95)

Both sets of data therefore lent strong support to the ‘moderate intensity activity’ hypothesis put forward by Blair – that total volume rather than intensity of activity was the key public health issue. And yet, Paffenbarger and his team appeared to remain uncertain in the final paragraph of their discussion – suggesting that they were still seeking to find some consensus with Morris’ team in Britain, albeit at a lower ‘threshold’ of intensity of energy expenditure: As Paffenbarger and colleagues commented:

“...the relative importance of the intensity as compared with the quantity of exercise for optimal health benefit is not easily determined, since men who engaged in moderately vigorous sports activity were also those who had a higher physical-activity index. Yet in earlier analyses, [see above] the lower risk of death associated with a physically active lifestyle was even lower among the men who engaged in moderately vigorous sports activity each week. Although the Multiple Risk Factor Intervention Trial [**Leon et al 1987**] showed little or no added benefit of exercising beyond a moderate level, British civil servants had lower rates of coronary heart disease and death only when they engaged in moderately vigorous recreational activity [**Morris et al 1990**] What kinds of physical activity should be prescribed, how much, how intense and for whom if optimal health and longevity are to

be achieved remain unanswered questions that require further clarification.”
(Paffenbarger et al 1993 p 544).

8.5 Lee et al 1995: *Exercise Intensity and Longevity in Men*

Paffenbarger and colleagues (**Lee et al 1995**) appeared to have remained vexed by these ‘unanswered questions that require further clarification’ because just two years later they published more results from their *Harvard Alumni Study* (entitled *Exercise Intensity and Longevity in Men*) which focused on the core issue of exercise intensity, mortality, and what public health advice should therefore be issued to the American public. They prefaced their results by remarking upon a “lack of consensus and the fact that few studies have compared directly the relative merits of vigorous and nonvigorous exercise”. **(op cit p 1179)**

The authors used the same design protocol as in previous reports: This time their prospective cohort study included 17,321 graduates whose mean age was 46 with follow up now extended to 1988.

Once again they noted Morris’ repeated finding that exercise beyond a ‘vigorous threshold’ (7.5 kcal/min or 6+ METs) was necessary to reduce coronary heart disease risk significantly. Further, they introduced new data from Finland, published only months before in the *New England Journal of Medicine* (**Lakka et al 1994**) which they interpreted as demonstrating: “...that only more intense, conditioning physical activity reduces the risk of myocardial infarction; less intense, nonconditioning activities have no effect.” **(Lee et al 1995 p 1179).**

They further noted that the prevailing, but unofficial (non-governmental) guideline advice from the American College of Sports Medicine was still advocating vigorous exercise “intense enough to produce sweating or hard breathing (60% to 90% of maximum heart rate) for at least 20 minutes, three times per week.” **(op cit p 1179)** However, Paffenbarger and colleagues drew equal attention to a new review of the literature by an ‘expert panel’ that would (it will be argued below in this chapter) shift the public health debate firmly in favour of far more moderate activity:

“Recently, the Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM) issued a new less stringent recommendation: **[Pate et al 1995]** ‘Every US adult should accumulate 30

minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.’” **(Lee et al p 1179)**

It is important to note that Paffenbarger was a member of this ‘expert panel’, and therefore a co-author of this ‘new less stringent recommendation’. Why then, with a ‘lack of consensus’ and when unanswered questions in the intensity debate still needed clarification, did the US government (through the CDC) evidently and abruptly switch its public health exercise advice from 3 shorter bouts of vigorous activity weekly, to at least 5 longer durations of ‘moderate-intensity’ activity that could even be accumulated (in 3 x 10 minute sessions) daily? And why did Paffenbarger lend his name and considerable reputation to this new prescription? The answers may lie less with science than in the social perception among both investigators and policy makers that the large bulk of sedentary Americans simply would not attempt, much less adhere to, a vigorous activity programme: Paffenbarger and colleagues stressed: “This recommendation was meant to encourage more exercise among the almost 60% of US adults who engage in little or no leisure-time activity.” **(op cit p 1179 and personal communication with RS Paffenbarger, Berkeley, California August 2002).**

Which guideline advice was “the more valid stance?” asked Paffenbarger and his colleagues. “Is, for example 2100 kJ (500 kcal) expended in vigorous exercise associated with the same decrease in mortality risk as an equal amount expended in non-vigorous activity?” **(op cit p 1179)** Judged by their latest Harvard data, which the authors then went on to reveal, the new ‘moderate advice’ appeared not only to be lacking a verified scientific foundation, but was apparently falsified by some of the available data.

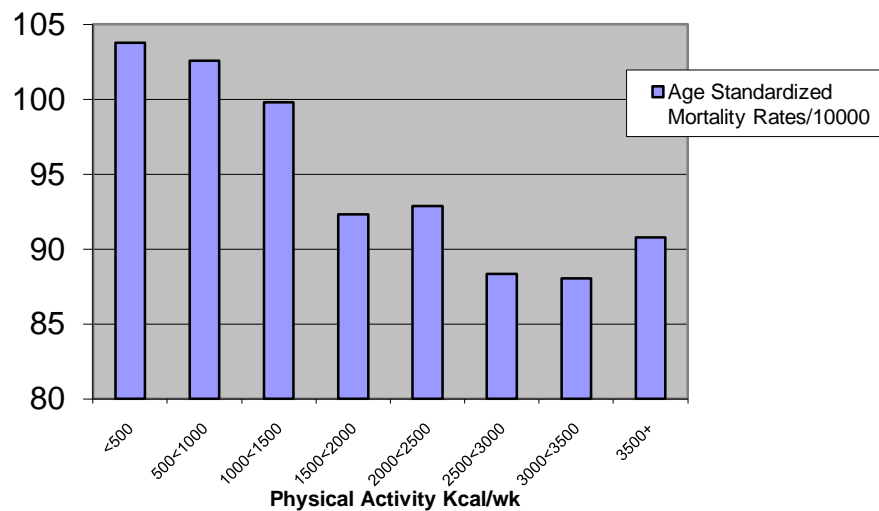
8.5.1 Latest Results from the *Harvard Alumni Study*

Fortunately, from the point of view of accurate comparison and consistency, the authors reverted to the standard, and commonly accepted classifications when defining ‘vigorous intensity’: “We were interested in two components of total energy expenditure: that derived from vigorous activities (requiring ≥ 6 METs) and that from non-vigorous (ie, light, and moderate activities requiring <6 METs).” **(op cit p 1180).** Paffenbarger and colleagues again relied on the alumni’s self-reported ‘physical activity index’, but this time calculated not only total expenditure on all activities **(Figure 8.5)**, but also expenditure exclusively from vigorous activities alone **(Figure 8.6)** and finally expenditure exclusively from nonvigorous activities **(Figure 8.7)** Their conclusions seemed clear: First they appeared to verify the ‘total volume hypothesis’: “Mortality

generally declined with increasing total energy expenditure ($P=.001$).” (**op cit p 1181**) The authors examined the ‘vigorous threshold hypothesis’ of Morris, using the same minimum threshold of intensity (7.5 kcal/min) as he did. Apparently Morris’ hypothesis was verified too: “Mortality also declined with higher levels of vigorous energy expenditure, regardless of the level of nonvigorous activity, up to 12,600 kJ/wk [3,000 kcal/wk].” (**op cit p 1181**) But when non-vigorous activity alone was examined, the authors reported: “On the other hand, nonvigorous energy expenditure, regardless of the level of vigorous activity, was not associated with mortality ($P=.87$).” (**op cit p 1181**)

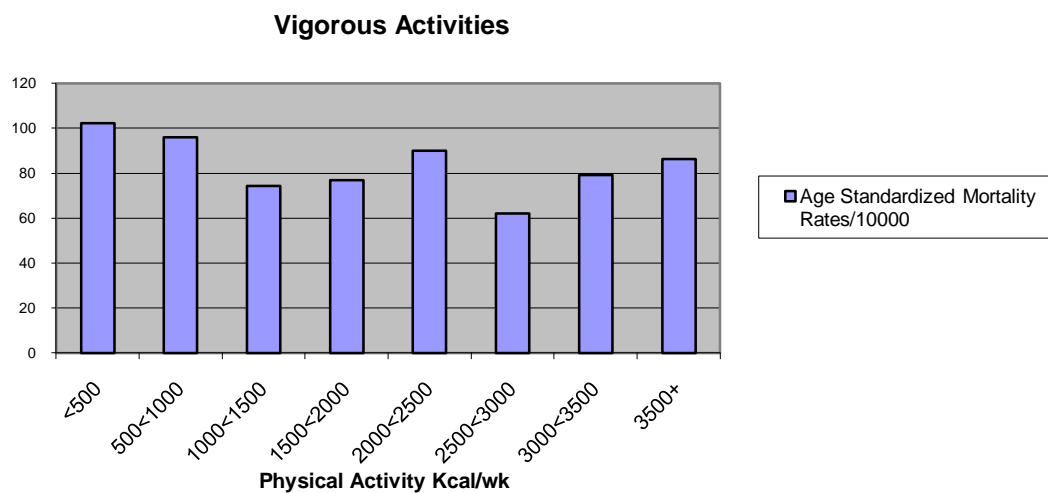
Figure 8.5

Age Standardized Mortality Rates Among Harvard Alumni 1962 or 1966 Through 1988, According to Energy Expended on All, Vigorous, and Nonvigorous Activities



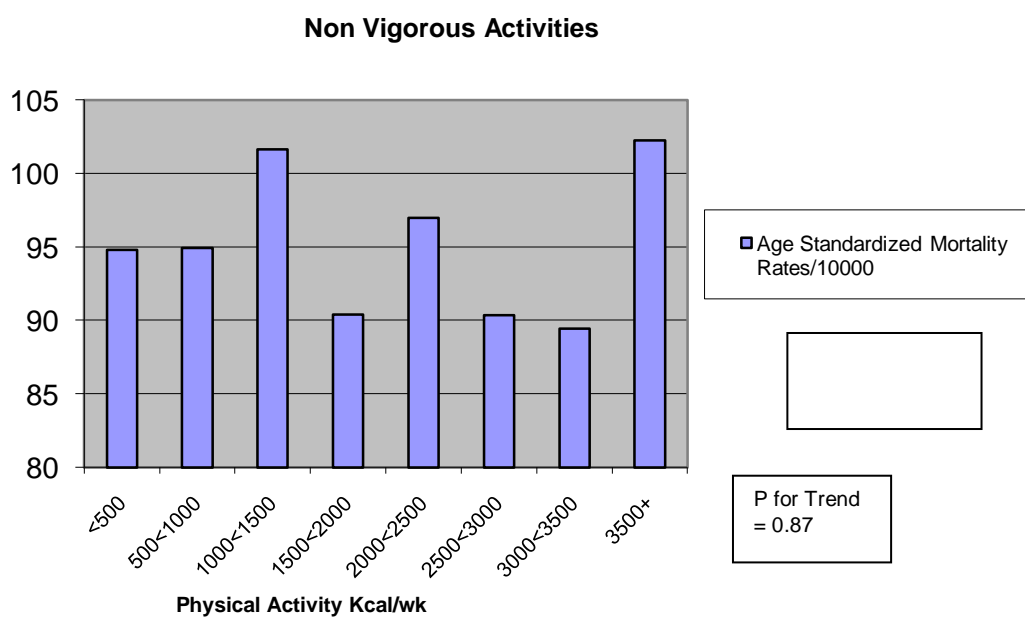
Source: **Lee et al (1995)** Table 2 p 118

Figure 8.6



Source: Lee et al (1995) Table 2 p 1181

Figure 8.7



Source: Lee et al (1995) Table 2 p 1181

The authors did not discuss, and therefore presumably did not think important, the 'out-lier' in their data where, in all three in categories (Figures 9.5, 9.6 and 9.7) there was a small rise in mortality at the energy expenditure level of 2000-2500 kcals. In any event, their conclusion must have been that the 'total volume hypothesis' (**Figure 9.5**) was only verified if a portion of that total energy expenditure came from vigorous

activities, because when 'total volume' was stripped of all 'vigorous activity' (**Figure 9.7**) no significant association with mortality was found. After conducting "multivariate analyses for vigorous and nonvigorous energy expenditure, while simultaneously adjusting for potential confounders," the authors concluded: "Vigorous energy expenditure again was significantly and inversely related to mortality ($P=.007$), whereas the trend for nonvigorous energy expenditure again was not significant ($P=.36$)." **(op cit p 1181)**

In each category of exercise the authors noted once again, a reverse **J** curve with an unexpected increase in mortality at the highest weekly kcal expenditure. Some investigators explained this phenomenon by "increased oxidative stress associated with prolonged physical exertion" (**op cit p 1182**), although Paffenbarger and colleagues remained uncertain. What they did remain certain about, however, was that vigorous activity showed a highly significant inverse linear association with mortality – whereas non-vigorous activity did not.

8.5.2 Comment by the Authors

Paffenbarger and colleagues commented: "Of the components of total physical activity, we found vigorous (activities at ≥ 6 METs) but not nonvigorous (< 6 METs) exercise to be associated with decreased mortality....This difference in mortality risk is of approximately the same magnitude as that between alumni 20% or more overweight and those of ideal weight or that between alumni who smoked one pack of cigarettes or less daily and nonsmokers." **(op cit p 1182)**

In searching for the mechanism by which vigorous activity protected against mortality – and particularly cardiovascular death, the authors said it was unclear, but observed:

"It is unclear to us why vigorous, but not nonvigorous, physical activity is associated with greater longevity. A recent report [**citing Lakka and Salonen 1992**] suggested that for favorable changes in high-density lipoprotein cholesterol and triglyceride levels, a threshold intensity of 5 to 6 METs of conditioning exercise is needed." **(Lee et al 1995 p 1182)**

Alternatively, they suggested that cardiorespiratory fitness, induced by vigorous exercise, is the key element, although they suggested that all methods of vigorous exercise are not equal:

“Perhaps the inverse association between physical activity and mortality is related not so much to exercise itself, but to the improved cardiorespiratory fitness that is induced. Vigorous exercise is more effective than nonvigorous activity for cardiorespiratory conditioning. The kind of vigorous activity also may be relevant; for example, jogging, which is sustained and dynamic, is effective for such conditioning, whereas heavy yardwork [such as garden digging] is unlikely to be as sustained and thus would be less effective in conditioning.” **(Lee et al p 1182)**

8.5.3 Summary of Lee et al 1995

The data presented in this paper **(Lee et al 1995)** unequivocally indicated that total energy expended on physical activities **(op cit Table 2 p 1181)** only enhanced longevity when a proportion (not defined in the paper) of it was expended at vigorous intensities (≥ 6 METs). In stark contrast, non-vigorous activities alone showed no significant improvement to longevity. However, the authors chose, apparently either to ignore, or essentially to discount their own scientific evidence about threshold exercise intensity when they ended their paper with this apparently contradictory public health advice:

“Our findings indicate that sedentary individuals should increase their activity level to enhance longevity. Specifically, vigorous activities were associated with greater longevity.” **(op cit p 1183)**

One might expect, therefore, that the authors would encourage the public at least to strive to attain some modest bouts of vigorous activity. But they concluded instead:

“However, we strongly believe that even nonvigorous exercise is preferable to sedentariness. Our findings pertain only to all-cause mortality; meanwhile, even modest exercise has been shown to improve, for example, lipid and glucose profiles.” **(op cit p 1183).**

Yet this strongly expressed belief was confounded by their own data. It was almost as if the primary scientific investigation and conclusion of this study – that only activities performed at vigorous intensity could improve longevity – had undermined the authors’

personal public health aspirations to change the sedentary behaviour of the American public.

8.6 Emergence of a Public Health ‘Consensus’ in Support of Moderate-Intensity Physical Activity Guidelines: 1990-1995

Further evidence that the official US public health policy was about to swing in favour of moderate intensity activity first began to emerge from two non-governmental, but highly influential sources: The American College of Sports Medicine (ACSM) – and even more importantly, the American Heart Association (AHA) – the only medical health charity which would be invited directly to participate in the internal construction of the US Surgeon General’s 1996 report.

However, a brief examination is first needed about the evolving position of the American College of Sports Medicine (ACSM), the professional body founded in 1954 that speaks for exercise physiologists and other practitioners involved in sports medicine. By tradition the ACSM had established itself as the benchmark provider of public exercise advice in a series of ‘position papers’. Its original statement in 1978 had, de facto, set US public health advice in the absence of an official declaration from, but with the apparent approval of, the US Department of Health (and Human Services). **(USSG 1996 p 22)** For cardiorespiratory fitness and body composition among ‘healthy adults’, it recommended: aerobic exercise training, 3-5 days per week, for a duration of 15-60 minutes per session, and most notably at an intensity of training of 60-90 percent of maximal heart rate (equivalent to 50-85 percent of maximal oxygen uptake (VO₂ max)). **(ACSM 1978)** This ‘vigorous’ intensity recommendation met, or exceeded the ‘threshold’ intensity elucidated in 1973 by Morris **(Morris et al 1973)**.

Broadly, this ‘vigorous’ activity advice was repeated by the ACSM on several occasions until 1990 when a distinct change was introduced. **(USSG 1996 pp 22-28)** The ACSM’s ‘vigorous’ exercise prescription remained similar, but the College also began (within all physical activity) to distinguish between exercise chosen primarily to promote cardiorespiratory ‘fitness’ and that aimed, more generally (and perhaps vaguely) to promote ‘health’. Broadly, ‘fitness’ and ‘health’ were, in effect, markers respectively for 1: definitions of vigorous activities and exercise exerted at or above a scientifically defined intensity threshold, and 2: more leisurely, moderate activities and exercises done below that threshold which, while less efficient at increasing ‘fitness’, were, nonetheless judged to be beneficial, to a greater or lesser extent, across a variety of

health outcomes. With this basic distinction, the ACSM was, it is argued here, moving away from its more narrow role as the academic arbiter of exercise physiology in elite sport to embrace, as well, a broader, more egalitarian public health role. The ACSM said in 1990:

“Since the original position statement was published in 1978, an important distinction has been made between physical activity as it relates to health versus fitness. It has been pointed out that the quantity and quality of exercise needed to obtain health-related benefits may differ from what is recommended for fitness benefits. It is now clear that lower levels of physical activity than recommended by this position statement may reduce the risk for certain chronic degenerative diseases and yet may not be of sufficient quantity or quality to improve [maximal oxygen uptake]. ACSM recognizes the potential health benefits of regular exercise performed more frequently and for longer duration, but at lower intensities than prescribed in this position statement.” **(ACSM 1990 – quoted in USSG 1996 pp 22-23)**

Both the 1978 and 1990 statements were published in the ACSM's own journal which, in the 1970s had been named: *Medicine & Science in Sports*. By 1990 the name had been broadened to *Medicine & Science in Sports & Exercise* **(MSSE)** – arguably further evidence that the College was now eager more fully to embrace an audience and public health issues that were wider than the science of exercise physiology that focused primarily upon elite athletes and sports alone.

8.7 American Heart Association (AHA) 1990 – 1995: Position Statements and Physical (In)Activity Workshop

The American Heart Association (AHA) played an important, unusual and arguably unique role in the formulation of US public health physical activity guidelines in the 1990s. This participation was born from its growing acceptance that physical (in)activity was a key risk factor along with those already identified (saturated fat/high LDL cholesterol, high blood pressure and cigarette smoking) in cardiovascular disease. In turn, this acceptance by such a rich and powerful medical charity and pressure group would play an important role in promoting the status of physical activity investigators as key members of the public health community – a role first prominently called for by Powell and Paffenbarger a decade earlier **(Powell and Paffenbarger 1985)**. This new status would begin to influence how key investigators evaluated and interpreted existing and emerging scientific data – especially when this data was central to the

debate about setting, or modifying existing, public health physical activity 'guideline' recommendations.

Although death rates from cardiovascular disease had begun to fall from a peak in the 1960s (**Beaglehole et al 1993 p 84**), cardiovascular disease (CVD) remained then and now the single biggest cause of adult death in the United States. The *Framingham Heart Study* had also established a strong association between physical activity and heart disease risk reduction as long ago as 1967. But this declaration by the Study (**Kannel WB 1967 p 811-12**) had failed to propel the science of physical activity study into a prominent role in the public health arena. However, this early recognition of physical activity's benefit in reducing the incidence, severity and mortality of heart disease did come well before similar links were to be made between physical (in)activity and other major diseases (most notably diabetes, colon cancer and morbid obesity) in the United States. By 1972 the AHA published its first, and one of the earliest guideline recommendations for physical activity to prevent coronary heart disease (CHD). In line with then current thinking it proposed very vigorous exercise: 70-85% maximal heart rate for 15-20 minutes for 3-7 x week. (**USSG 1996 p 25**)

8.7.1 AHA 1990: Intensity of Exercise: A Mixed Message

By 1990 the AHA had forged alliances with the ACSM, and its position – particularly on the intensity of activity began to become more moderate – in line with the College's own evolving position on exercise intensity. And yet, its previous, vigorous advice had certainly not been discarded. The AHA's 1990 Position Statement (**American Heart Association 1990 Statement on Exercise**) indicated that its authors either were in disagreement on the intensity question, or were collectively uncertain which guideline advice was now best to offer: A few excerpts illustrate this conflict or uncertainty:

“The evidence suggests that regular, moderate, or vigorous occupational or leisure-time physical activity may protect against overt coronary disease.”
(**op cit p 396**)

Only a few paragraphs later, however, the advice appeared to favour vigorous intensity with descriptions of “physically demanding”, “strenuous” or “dynamic” exertion:

“Epidemiological data suggest that men who work in physically demanding jobs or perform strenuous recreational activities have less overt coronary artery disease in middle age.” (**op cit p 396**)

And further, with a public health message apparently in mind:

“In prevention and health promotion, large muscle dynamic exercise for extended periods of time (30-60 minutes, 3-4 times weekly) is recommended.” The suggested, broadly vigorous activities: “jogging, running, bicycling, rowing, swimming and selected sports” were described as “especially valuable.” **(op cit p 397)**

And yet, in the very next sentence the authors raised the concept of the ‘brisk walk’ and began to test the core question of the growing public health debate: Just how beneficial might more moderate intensity activity be as protection against heart disease as compared to the vigorous prescription?

“Brisk walking at 50% of capacity may be as beneficial as jogging or running.” And yet, with apparent contradiction, they continued: “The training effect resulting from performance of such activities is most apparent at intensities exceeding 50% of a person’s own exercise capacity....” **(op cit p 397) (emphasis added)**

8.7.1.1 Exercise intensity as a risk factor in causing (and aiding rehabilitation from) heart attacks:

The ‘training effect’ referred to by the AHA meant the level of improvement in cardiorespiratory fitness (VO2 max) at which the heart needs to work less hard to achieve any given level of energy expenditure (kcal/min or METs) -- a healthy condition, as Morris first theorised, which was protective against heart disease/attacks **(Morris et al 1953, 1973)**. However the AHA also focused upon and highlighted the known dichotomy that strenuous exercise, while protecting populations from heart attacks in the long-term, could, nevertheless, also increase the immediate risk of inducing a sudden heart attack in susceptible, but asymptomatic and undiagnosed, individuals. **(Siscovick et al 1985, Curfman GD 1993a, 1993b)** Conversely, exercise might be used (at judicious intensity and duration) as a therapeutic tool for people recovering from heart attacks, but only in moderation. The AHA advised:

“Clinical trials suggest (but do not prove) that medically prescribed and supervised exercise can reduce morbidity (including re-infarction) and mortality rates of patients with ischemic heart disease.....To the contrary, excessive exercise, particularly in patients with significant ischemia, may be harmful, and patients should be counselled about possible risk.” **(AHA 1990 p 397)**

Thus, was it possible to say, in public health terms, what levels of intensity and duration of physical activity were 'safe' to enjoy and benefit from, without significantly risking heart attack or general injury? The AHA felt able to conclude:

"While cardiovascular and orthopaedic complications may occur, they are infrequent at intensities less than 75% of capacity. These problems can be minimized with use of proper shoes, equipment and training techniques. The training effect of regular physical activity is best achieved with 30- to 60-minute sessions every other day." (**op cit p 397**)

This 1990 advice appeared, therefore broadly to affirm the 'vigorous' prescription previously recommended, albeit not at the 85% maximal heart rate previously suggested. And yet, the AHA added, just one year after Blair's groundbreaking (and headline making) report (**Blair et al 1989**): "The evidence also suggests that daily low-intensity activities may have some long-term health benefits in terms of lower risk of cardiovascular disease." (**AHA 1990 p 397**).

8.7.2 AHA 1992: Moderate Intensity Activity: Firmly Recommended

Two years later the American Heart Association substantially shifted its position with a second Statement on Exercise. (**American Heart Association 1992 Statement on Exercise**). Its previous statement was addressed narrowly to 'health professionals'. This time, however, the AHA sought not only to address health professionals, but also directly to intervene in the public health arena, by entitling its new statement: *Benefits and Recommendations for Physical Activity Programs for All Americans*. The new AHA statement also concluded on a strongly non-elitist, public health note:

"In summary, future development and study should be not only of the benefits of physical activity, but also of the methods used to facilitate the dissemination of the present and future body of knowledge to all members of society." (**op cit p 343**)

Among new authors brought in to assist analysis were Steven Blair of the Cooper Institute in Dallas, Texas and Carl Caspersen from the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia. Both men had been contributors to the 1984 CDC Workshop (**Powell and Paffenbarger 1985**) and had continued to promote physical activity's importance in public health.

When addressing issues of science, references in the 1992 position statement to the benefits of vigorous intensity activity were now few and imprecise, while concern about its cardiac risks were heightened. It opened simply with: “Modest levels of physical activity are beneficial.” **(AHA 1992 p 340)**. This knowledge claim was unreferenced and the loose terms ‘modest’ and ‘levels’ were not defined.

Two statements did, however, remain that suggested there might still be a public health role for vigorous intensity activities: “Middle-aged men and women who work in physically demanding jobs or perform moderate to strenuous recreational activities have fewer manifestations of coronary artery disease than their less active peers.” **(op cit p 340)**

Another 1992 AHA recommendation, drawn directly from the AHA’s 1990 statement, might also be construed as still promoting vigorous activity (‘dynamic exercise’), but again, precise intensity was not described – and nor was the term ‘health promotion’: “For health promotion, dynamic exercise of the large muscle groups for extended periods of time (30-60 minutes, three to four times weekly) is recommended.” **(op cit p 340)** Vigorous activities including jogging, running, racquetball and soccer were mentioned favourably. But emphasis was again put on the new concept of “brisk walking” – described as “also an excellent choice”, although no attempt was made to define a relative or absolute intensity of ‘brisk’. **(op cit p 341)**

Furthermore, the risks, both cardiac and from muscle/joint injuries, of more intense exercise were now emphasised, and the previous reassurance, that activities performed at $\leq 75\%$ of maximal heart rate ‘minimized’ any dangers, was now absent:

“Physical activity has risks as well as benefits. Estimates of sudden cardiac death rates per 100,000 hours of exercise range from 0 to 2.0/100,000 in general populations and from 0.13/100,000 to 0.61/100,000 in cardiac rehabilitation programs. Falls and joint injuries are additional risks associated with physical activity (especially in older women), but most of these are not likely to require medical treatment. The incidence of such complications is less in patients participating in lower-intensity activities like walking.” **(op cit p 341)**

The benefits of lower intensity activities were emphasised several times:

“The evidence also supports the notion that even low-intensity activities performed daily can have some long-term health benefits and lower the risk

of cardiovascular disease.” Those mentioned included walking for pleasure, gardening, yard work, and housework. **(op cit p 341)**

According to Steven Blair, in this document the American Heart Association for the first time fully embraced physical activity -- on a par with cigarette smoking cessation and low density cholesterol and blood pressure reduction – as a key public health tool to reduce the incidence and severity of cardiovascular disease: **(personal communication with SN Blair, London September 2006)** Doctors were firmly (and repeatedly) reminded that the preferred physical activity prescription for a highly sedentary nation was, walking. The AHA 1992 Statement advised doctors that:

“Preventative services are an important component of the national health agenda. Physicians have the opportunity and responsibility to promote regular exercise as well as the reduction of high blood pressure, management of abnormal blood lipids, and prevention and cessation of smoking....The physician must not neglect this responsibility to promote regular exercise and other health promotion strategies...In addition, physicians should encourage their more sedentary patients to adopt a more active lifestyle and emphasize the risks associated with inactivity. Walking should be advocated as a form of exercise.” **(op cit p 341-2)**

Educators must also encourage all their students to participate in physical activity, and not just the gifted elite:

“Schools at all levels should develop and encourage positive attitudes toward physical exercise....The school curriculum should not overemphasize sports and activities that selectively eliminate children who are less skilled. Schools should teach the benefits of exercise and the development and maintenance of exercise conditioning throughout life.” **(op cit p 342)**

Yet, in spite of their evident decision to downplay the importance of vigorous intensity activity to promote maximum cardiorespiratory fitness – and instead to adopt moderate-to-lower intensity activities as its main public health message -- the authors of the AHA statement conceded that the science behind this policy judgement remained incomplete – not least on the key issue of a ‘minimal-intensity threshold’:

“There is a large body of knowledge on exercise, but data on exercise and its effects on the cardiovascular system and long-term survival are limited.....Basic knowledge of the anatomic, biochemical, and physiological

changes that result from various patterns of physical activity (acute and chronic, sustained and intermittent, isotonic and isometric, low-intensity and high intensity) in persons of different ages is needed as is a determination of whether a certain minimal-intensity threshold of physical activity is required for benefit.” (op cit p 342)

8.7.2.1 Summary of AHA 1992

The modern investigation of associations between physical activity and heart disease had first been initiated by Morris in 1953 (**Morris et al 1953**) and further developed by the US Department of Health led *Framingham Heart Study* in 1967. But it was not until the early 1990s (as seen in its 1990 and 1992 Position Statements) that the American Heart Association threw its full weight behind promotion of physical activity as a primary public health tool to reduce the incidence and severity of heart disease. In doing so, it chose to invite Steven Blair and Carl Caspersen to help guide it toward adoption of a moderate intensity message, even though the scientific evidence to downgrade the importance of vigorous intensity activity was, by its own admission, uncertain.

8.7.3 AHA Prevention Conference 1993: Arguments are Assembled for Discarding Vigorous Guidelines in Favour of Moderate Guidelines

In just two years (1990 – 1992) the American Heart Association moved swiftly to embrace the public health importance of physical activity – and in so doing, seriously to question the value and validity of existing vigorous intensity guidelines which called for 20 minutes of vigorous activity (≥ 7.5 kcal/min ≥ 6 METs) three or more times a week.

The following year, 1993, the AHA convened a Prevention Conference to consider which ‘behaviour change’ strategies could best be implemented in its continuing campaign to reduce cardiac morbidity and mortality. It convened 5 workshops bringing together leading investigators into 5 of the key risk factors: Tobacco use, Blood Pressure, Obesity, Lipids, and Physical (In)Activity.

8.7.3.1 Vigorous exercise and increased risk of sudden heart attack

Not only was physical activity the newest category of coronary prevention, it was also unique in a complex, and problematic way: It could be, or was perceived to be, a hindrance as well as a help in maintaining a healthy heart.

Cessation of smoking, lowering of high blood pressure, reduction of unhealthy weight, and improving of lipid (cholesterol) profile each brought favourable behavioural and clinical changes which, universally and unequivocally, could be relied upon to reduce coronary risk in most individuals, and certainly in public health terms.

Similarly, activities of vigorous intensity and considerable duration were, arguably and theoretically at least, the most effective 'dose' for most people in improving cardiorespiratory fitness. Evidence also suggested that physical activity was effective in reducing directly, or was protective against, the other coronary risk factors (sedentary living, tobacco smoking, high blood pressure, unhealthy weight, and poor lipid profile). Vigorous activity and cardiorespiratory fitness had also been shown to be particularly effective in protecting against two of these risk factors (unhealthy weight gain and by increasing levels of "good" HDL cholesterol). **(Blair et al 1983, Folsom et al 1985, and Lakka and Salonen 1992)**

However, in susceptible and often asymptomatic individuals, vigorous intensity activity, especially among older and least fit people, could also pose the greatest risk of sudden heart attack and death, a most unfortunate profile for such a useful public health tool. **(AHA 1992 p 341)** Indeed, renewed concerns about the risks of strenuous exercise and heart attacks had begun surfacing prominently in the *New England Journal of Medicine* **(NEJM)**.

In February 1993 the Journal's deputy editor, Gregory D Curfman questioned the validity of 27 recently reviewed observational studies **(Berlin and Colditz 1990)** which appeared to show a consistent association between habitual physical activity and primary coronary prevention. This meta-analysis embraced and extended the work of Powell **(Powell et al 1987)** and came to the same broad, and apparently uncontroversial conclusion: "that methodologically stronger studies tend to show a larger benefit of physical activity [in risk reduction from cardiac death] than less well-designed studies". **(Berlin and Colditz p 612)**

However, Curfman argued that these still ‘unproven’ benefits:

“....must be viewed in the light of the complications of exercise, the most feared of which is sudden cardiac death.....Although the hypothesis that regular exercise can prevent coronary disease and prolong life is supported by many observational studies, it has not yet been unambiguously proved. Until the answer is known, the public should be given the straight facts and spared the hype, so that each person can make an informed decision about the appropriate place of physical activity in his or her personal life.”

(Curfman GD 1993a pp 574-5)

The editorial was rebutted in the **NEJM** in June 1993 by Carl Caspersen and two other senior investigators at the CDC. They wrote, apparently embracing even older, less fit individuals that:

“Public health policies to promote physical activity among all population groups must not be delayed simply because of a lack of randomized, controlled trials on this subject. The promotion of physical activity to prevent coronary heart disease is not hype from a selected group of exercise advocates, but a reasoned and appropriate public health response to the accumulated scientific evidence.” **(Livengood et al 1993)**

However, in December of the same year Curfman replied when he reviewed two new reports in the **NEJM** which suggested “regular exercise provided protection against the (coronary) triggering effect of strenuous exertion.” He again concluded:

“The public health message of the two new studies is self-evident: although regular exercise has important health benefits over the long term, sudden, vigorous exertion by people who are unaccustomed to it can sometimes end in tragedy.” **(Curfman GD 1993b pp 1730-31)**

It is plausible that this high-profile debate may have encouraged the AHA workshop investigators further to focus on the benefits of moderate intensity activities and away from ‘vigorous exertion’ which could be linked to sudden heart attacks.

Perhaps even more importantly, a second argument was emerging that the advice offered by the existing vigorous activity guidelines might perversely be acting as a real, if unintended, deterrent to exercise for many unfit, sedentary Americans who felt: 1. Unable or unwilling to achieve such intensities and duration of exertion, and/or: 2. That less intense activities, which they might pleurably achieve and enjoy were

unfortunately of no, or very little benefit in improving their heart and/or general health. **(Haskell et al 1985, Blair et al 1992 and subsequently Pate et al 1995)** It was further believed that the risk of sudden cardiac attack was highest in the weakest, and often most sedentary groups in the population that were most often deterred, and even repelled, by public health exhortations to exercise vigorously: the elderly, the poor, and the increasing proportion of the growing sedentary segment of the American public who might also be carrying unhealthy weight (excess body fat% and/or Body Mass Index (BMI) >25). **(personal communication with KE Powell, Atlanta, Georgia May 2007)**

Third, and finally, some investigators, especially from exercise physiology backgrounds, may have felt that their credentials, and the vigorous exercise they had been espousing, might be seen as elitist (in narrowly caring only to improve the performance of elite athletes) and inappropriate in the world of public health and the dissemination of physical activity guidelines to the ordinary public.

These three factors (cardiac risk, deterrent to the sedentary, and fear of elitism) may have lain behind the strong preference for moderate intensity activity expressed in the AHA's 1993 physical inactivity workshop – the consensus paper from which, is discussed below.

8.7.4 AHA 1993 Physical Inactivity: Workshop V Report

The AHA Physical Inactivity Workshop was chaired by Steven Blair, and its key speaker was Kenneth Powell from the CDC.

The workshop participants argued, drawing from published US government survey data, that levels of leisure-time physical activity (LTPA) had been rising over the last 30 years in parallel with a similar decline in occupational labour. They suggested: “It is likely that with additional effort, participation in moderate physical activity could be appreciably increased and the rate of coronary heart disease further reduced.” **(AHA 1993 p 1402)**

The workshop report met the public health issue of intensity directly: “The single most important issue in the promotion of physical activity is the dose. How vigorous does the activity need to be? And how much does one need to do?” **(op cit p 1402)** It further argued that conventional ‘vigorous’ advice was both insufficiently proven and, arguably, unnecessary:

“Most promotional efforts have advocated vigorous activity, that is, activity requiring 50% to 60% or more of the cardiorespiratory capacity of young people (eg, running, swimming laps). However, of the many studies showing that regular activity is associated with a reduced risk of coronary heart disease, very few have demonstrated that such intense activity is required.” **(op cit p 1402)**

The authors of the report provided no citations to support their claim that ‘very few [studies] have demonstrated that such intense activity is required.’ However, they stopped short of claiming that vigorous intensity was not best for heart health, but insisted that more moderate activities were very beneficial too:

“High-intensity activity may be necessary to achieve the maximum benefit, but the evidence is clear that high intensity is not necessary to appreciably reduce the risk of coronary heart disease.” **(op cit p 1402)**

However, no citations were provided for this ‘clear evidence’. Indeed, the authors further acknowledged that the dose or amount of moderate activity needed to achieve this appreciable risk reduction was not certain. They did, however, refer to Powell’s review **(Powell et al 1987)** which affirmed the standard assumption that the dose-response curve was broadly linear and that, across tertiles, risk reduction was significant not only between the most active and least active – but also, and crucially to their argument, also significant “between the least active group and the next least active.” **(AHA 1993 p 1402)**

8.7.4.1 Population Attributable Risk: The core of the new public health calculation

Crucial to understanding why the AHA so quickly and comprehensively endorsed the ‘moderate activity message’ was the development by Powell and Blair of their concept of population attributable risk (PAR) in relation to physical inactivity among the large, and expanding population of sedentary Americans. Their paper **(Powell and Blair 1994)** has been discussed earlier in this chapter and was cited by the AHA workshop as being ‘in press’. The workshop participants might equally have relied upon Blair and Paffenbarger’s 1992 collaboration **(Blair et al 1992)** also discussed earlier in this chapter) which made essentially the same ‘greatest good for the greatest number’ argument:

“People who are sedentary or irregularly active are at highest risk of coronary heart disease and stand to benefit the most from even small increases in physical activity. It is estimated that 20,000 fewer deaths per

year would occur if half of those who participate in no leisure-time physical activity would do something just a few times per week.” **(AHA 1993 p 1402)**

This ‘estimation’ appeared to rest on two interlocking ‘foreground’ assumptions: First, that even very modest doses of low-to-moderate activity taken ‘a few times per week’ by sedentary Americans would significantly reduce their coronary risk, and second, that discarding the primary vigorous activity public health prescription in favour of the more palatable ‘moderate message’ would actually activate – and continue to motivate – a sizable proportion (half) of the target American sedentary population to sustain and incorporate agreeable leisure-time activity into their new, healthier lifestyles (long term ‘adherence’). In addition, the likelihood that sedentary people might suddenly attempt cardiac-threatening vigorous exercise regimes would be reduced: They argued that:

“Moderately intense activities are associated with lower risk of orthopaedic injuries and cardiovascular events than are vigorous activities. They are more likely to entice sedentary and unfit individuals to participate and persist and are less likely to require medical supervision than if the only focus is on more vigorous sports activities....Moderate levels of physical activity such as brisk walking should be promoted and the functional and health benefits of such activities emphasized. Life-style interventions in which increased activity is integrated into daily routines may be easier for many people to adopt than traditional programmed exercise.” **(op cit p 1403).**

Once again, the authors cited no scientific evidence for these behavioural suppositions. Instead they apparently relied on the ‘common sense’ notion that unfit, sedentary and quite possibly overweight people would be more likely, in effect, to find time for, and stick more faithfully to, a new ‘lifestyle’ routine of at least 5, half-hour ‘brisk’ walks a week, than to endure the old, more vigorous 20 minute/ day routine – even though the latter required fewer days/wk (3) and substantially less time – just 1 hour a week, compared with at least 2½ hours a week.

This supposition of greater adherence was crucial to the logic of their argument, because the authors did not go further to suggest that moderate physical activities might be more appropriate physiologically, and thus clinically more effective, among a largely sedentary population/patient pool:

“Efforts to get the least active people to do something will provide them with benefits whether or not they meet traditional exercise guidelines. This does not mean, however, that modest amounts of activity provide maximum reduction in coronary heart disease risk.” **(op cit p 1403)**

8.7.4.2 Concern about Adherence Strategies

As Powell and Paffenbarger observed in 1984 **(Powell and Paffenbarger 1985)** the scientific and medical discipline of physical activity had only been recently recognised and embraced by the public health community, mainly through the efforts of the CDC and thereafter by the American Heart Association. It may not be surprising, therefore, that comparatively little time and energy had been spent exploring, interpreting and applying the social science strategies of behavioural psychology to discover how individuals, and especially sedentary people, might be persuaded in real life and on a population scale, to incorporate physical activity into their daily, or at least weekly, lifestyles. According to Michael Pratt of the CDC “fewer than a dozen” well designed intervention studies to determine likely adherence behaviour had been published in the physical activity field by the mid 1990s. **(personal communication with M Pratt January 2007)**. Indeed, a recent AHA ‘scientific statement’ on such studies was even less complementary about the quality of design than Pratt: It said: “In prior decades, physical activity research was largely atheoretical; however, in the last decade, there has been much more focus on the importance of theory. **(AHA 2006 Marcus et al)**

As a result, the physical activity investigators also tended to draw extensively upon existent literature within the behavioural sciences, and particularly from work done on cessation of tobacco smoking. The workshop report observed:

“The incorporation of any behaviour as a regular and permanent part of daily living proceeds through several stages. Some people, for example, are not thinking about increasing their activity, and others are thinking about it but have not yet acted. The Stages of Behavior Change Model, originally developed for smoking cessation, describes these stages and should be a useful model for the development and evaluation of physical activity promotion as well.” **AHA 1993 p 1402)**

8.8 CDC/ACSM Workshop 1993

In a search to explain the causes of Americans’ sedentary behaviour, some investigators also questioned, as previously discussed, whether their own previous advocacy of the then current vigorous activity guidelines had actually been counter-

productive in acting as an unintended deterrent to many individuals. This view was expressed in a draft and embargoed 'summary statement' from a workshop on 'physical activity and public health' convened in 1993 by the Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM). It asked, and underlined its own solution:

"Why are so few Americans physically active? Perhaps one answer is that previous public health efforts to promote physical activity have overemphasized the importance of high-intensity exercise. The current low rate of participation may be explained, in part, by the perception of many people that they must engage in vigorous, continuous exercise to reap health benefits. Actually the scientific evidence clearly demonstrates that regular, moderate-intensity physical activity provides substantial health benefits.....Every American adult should accumulate 30 minutes or more of moderate intensity physical activity over the course of most days of the week....One specific way to meet the standard is to walk two miles briskly."

(CDC/ACSM 1993 pp 2-3)

Once again, no references or citations were given for this 'scientific evidence' on the 'substantial health benefits' of moderate intensity activities.

8.8.1 Healthy People 2000: Conflicting goals

The workshop summary further highlighted the growing public health importance of physical activity by noting that it had been made a leading priority in **Healthy People 2000**, the omnibus public health targets set by the US Department of Health and Human Services in 1990 and revised in 1991 and 1995. **(USDHHS Healthy People 2000)** Physical Activity was listed first among 22 priority areas which also included nutrition, tobacco, substance abuse, mental health, cancer, HIV infection, diabetes and chronic disabling diseases. The CDC was cited as a lead agency for the entire report, but the lead agency for the physical activity section was cited as the President's Council on Physical Fitness and Sports, a largely symbolic body established in the mid 1950s during the Eisenhower Administration. **(personal communication with A Franks, Northampton, Massachusetts March 2007)** Importantly, the **Healthy People 2000** report listed separate and distinct target goals for both light to moderate and vigorous intensity activity. Both are reproduced in full below: **(USDHHS Healthy People 2000 – 1995 Revision p 34)**

Target 1.3

Increase to at least 30% the proportion of people aged 6 and older who engage regularly, preferably daily, in light to moderate activity for at least 30 minutes per day.

Baseline

22% of people aged 18 and older were active for at least 30 minutes 5 or more times per week; and 12% were active 7 or more times per week in 1985

Target 1.4

Increase to at least 20% the proportion of people aged 18 and older and to at least 75% the proportion of adolescents aged 6 through 17 who engage in vigorous physical activity that promotes the development of cardiorespiratory fitness 3 or more days per week for 20 minutes or longer per occasion.

Baseline

12% of people aged 18 and older in 1985; 66% for youth aged 10 to 17 in 1984.

The Healthy People 2000 targets for both light-to-moderate and vigorous intensity activity remained unchanged in the 1995 revision from the original goals in 1990, despite the strong pressure, beginning in the late 1980s, for a switch away from vigorous intensity to make moderate intensity activity the primary public health guideline recommendation as advocated by: Leon et al 1987, Blair et al 1989, Blair et al 1992 and Powell and Blair 1994.

It should be stressed that the baseline data for the Healthy People 2000 document were a decade out of date (1985). However, adherence to moderate intensity activity at 22% (with "light" activities included) may not have been so clearly superior to vigorous adherence (at 12%) as some advocates of moderate activity had been suggesting. It might also be reasonably assumed that the figure of 22% may have been inflated by inclusion of many of the vigorous adherents who also were likely to be undertaking light and/or moderate LTPA at the time of questioning. **(See Powell and Blair 1994 p 853 and personal communication with KE Powell, Atlanta, Georgia May 2007)**

The workshop's brief summary statement referred not once, but twice to the Healthy People 2000 report. However, it selectively mentioned only the low-to-moderate activity baseline and target without reference to the equally prominent baseline and target for vigorous intensity adherence reproduced above. No reason for this omission was

given, and nor was the Healthy People 2000's continued advocacy for vigorous intensity leisure time activity reported.

Curiously, the summary statement briefly reverted to a dual guideline message suggesting "almost all [Americans] should strive to increase their participation in moderate or vigorous physical activity", before concluding that its goal was singular and clear: "This recommendation has been developed to emphasize the important health benefits of moderate physical activity." (**CDC/ACSM 1993 p 3**)

8.9 American Heart Association 1994-95: Strategic Plan for Promoting Physical Activity

To underline its commitment to physical activity as a primary public health tool in reducing cardiovascular disease the American Heart Association next created a 'public activity sub-committee' whose members during 1993 and 1994 would convene to produce the association's Strategic Plan for Promoting Physical Activity (**AHA Strategic Plan 1995**). Once again, Steven Blair was co-opted to lead the project in developing policies for the general population and to co-chair it when it turned to policies for patients with known cardiovascular disease (CVD). Other prominent members included Russell Pate from the University of South Carolina (**see Pate et al 1995**), Michael Pratt from the CDC, and Terry Bazzarre, a staff scientist at the AHA who would become the only individual outside of government or academia chosen to join the planning board of the *US Surgeon General's Report on Physical Activity and Health 1996*.

The strategic plan had 4 primary components: (**AHA Strategic Plan 1995 pp 1-6**)

1. Support for the public health concept of Population Attributable Risk for physical activity as elucidated by Powell and Blair (**Powell and Blair 1994**) and the concomitant commitment to a strategy focused on getting the sedentary and inactive bulk of the population to take up regular moderate intensity activity, with very little emphasis placed on existing recommendations for more vigorous exercise.
2. A declaration from the AHA that it was now able and willing not only to make physical activity a top priority area within its own organisation, but also

to take the lead in establishing an 'interagency council' with partners including the CDC, American College of Sports Medicine, and the President's Council on Physical Fitness and Sports.

3. "Identify and establish mechanisms for incorporating the behavioural and social science basis for implementing physical activity programs into the strategic plan". **(AHA Strategic Plan 1995 p 1)** Two leading behaviourists within the discipline of physical activity (Bess Marcus from Brown University Medical School, and James Sallis from San Diego State University) joined the membership panel chaired by Steven Blair.
4. Adopt policies to promote physical activity "consistent with the Healthy People 2000 Objectives for children and adults." **(op cit p 1)**

The AHA Strategic Plan said:

"In support of its mission to reduce disability and death from cardiovascular diseases and stroke, the AHA will reduce the prevalence of physical inactivity and increase the percentage of people who are physically active, consistent with the Healthy People 2000 Objectives for children and adults."
(op cit p 1)

The authors of the strategic plan summarised and reproduced the goals of Healthy People 2000 in an appendix – including, not least, its dual targets for moderate and vigorous intensity activity. And yet, in setting their own target for American adults, the authors of the AHA Strategic Plan focused exclusively on getting sedentary and largely inactive people moderately active, citing in evidence the AHA 1993 Physical Inactivity Workshop already discussed:

"According to this [workshop] report **(AHA 1993)** epidemiological data suggest that the greatest impact on reducing CHD mortality can be accomplished by motivating the sedentary segment of the U.S. population to perform some level of physical activity on a weekly basis as part of its general lifestyle routines. Further reductions in mortality can also be achieved by encouraging people who are occasionally active to become physically active on a regular basis (i.e., engaging in a total of 30 minutes of moderately brisk physical activity on most days of the week." **(AHA Strategic Plan 1995 p 1)**

Later, in a section entitled “Behavior Change and Knowledge Outcomes for Adults”, the authors again emphasised the need for Americans to appreciate the value of non-vigorous exertion: “Be aware of and recognize the benefits of moderate-intensity activity.” **(AHA Strategic Plan 1995 p 4)**

Nowhere in the strategic plan were American adults urged even to consider vigorous intensity activities (not even after they might have comfortably achieved moderate intensity fitness). Nor was any explanation given as to why the vigorous intensity goal for adults in Healthy People 2000 was neither challenged nor addressed.

This omission appears even more inexplicable because the strategic plan clearly recommended dual goals of both moderate and vigorous intensity activities for all American children over 5 years. Indeed, the vigorous recommendation (at 30 minutes duration) exceeded the Healthy People 2000 goal (20 minutes or longer) and specifically aimed to boost cardiorespiratory fitness:

“All children (5 years of age or older) and youth should: Engage in vigorous physical activity that promotes developing and maintaining cardiorespiratory fitness 3 or more days/week for at least 30 minutes per occasion.” **(AHA Strategic Plan 1995 p 4).**

8.10 Pate et al 1995: Physical Activity and Public Health: The CDC/ACSM Alliance to Forge New Public Health Physical Activity Guidelines

As with the ground-breaking paper by Jeremy Morris **(Morris et al 1953)**, the landmark investigation by Steven Blair into all cause mortality in both men and women **(Blair et al 1989)**, so too publication of the ‘consensus view of an expert panel’ led by Russell Pate and colleagues **(Pate et al 1995)** stands out as having been immensely influential in shaping the post-World War II field of physical activity and public health. More than any other document, it spelt out the case for making moderate intensity activity the new single keystone of public health physical activity advice in the United States, and subsequently, via the World Health Organisation, throughout the Western World.

Although it was prominently published as a ‘Special Communication’ in the *Journal of the American Medical Association* **(JAMA)**, the paper brought forward no significant new evidence and arguably, no new insights into the science of physical activity and human health. But, by claiming the aegis of both the Centers for Disease Control and Prevention, and the American College of Sports Medicine, it carried quasi-official

authority in setting the stage, and arguably, largely determining the outcome of the US Surgeon General's report on physical activity and health published in the following year. Thus, it provided 'eminential', rather than 'evidential' institutionalised support for the 'moderate intensity hypothesis'.

The assembled 'group of experts' included Steven Blair, Ralph Paffenbarger, William Haskell, Michael Pratt (from the CDC) and most unusually, Jeremy Morris from the United Kingdom. Its tone was unashamedly populist and partisan in advocating a single and simple public health message in favour of moderate intensity physical activity:

"A group of experts was brought together by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) to review the pertinent scientific evidence and to develop a clear, concise 'public health message' regarding physical activity....The focus of this article is on physical activity and the health benefits associated with regular, moderate-intensity....Moderate physical activity is activity performed at an intensity of 3 to 6 METs (work metabolic rate/resting metabolic rate) – the equivalent of brisk walking at 3 to 4 mph for most healthy adults." (op cit p 402)

Once again, the concept of a 'brisk walk' – as the benchmark public health 'prescription' – was relied upon. Yet, the definition had changed. When first elucidated by Morris, the 'brisk walk' was precisely defined by him as "over 4 mph or 6 ½ km/ph". (Morris et al 1973 p 334) It was subsequently defined by Duncan in his 'Women Walkers' intervention study as precisely 4 mph or 6.4 km/ph (Duncan et al 1991 p 3295). Only once before had the definition of a 'brisk walk' dropped to less than 4 mph in a major investigation/analysis. This occurred when Blair (writing with Paffenbarger) defined their weekly public health prescription of a "brisk, two mile walk in 30-40 minutes taken on most days." (Blair et al 1992 p 115)

The speed reduction chosen by the authors of Pate et al does not appear to have been arbitrary, not least because the physical activity literature benefited then, and still does, from a widely agreed and authoritative 'compendium' (Ainsworth et al 1993 and Ainsworth et al 2000) of specific energy expenditures/intensities assembled for a long and detailed list of common physical activities -- with each ascribed a precise expenditure score measured in METs (metabolic equivalent of tasks). In the 1992 table available to the authors of Pate et al, walking at "3.0 mph on a level, firm surface" was

described not as “brisk”, but as a “moderate pace”. The definition of “brisk” was assigned only when a speed of 3.5 mph is reached, and 4 mph was described as “very brisk”. **(Ainsworth et al 1993 p 78)**

It remains unclear whether the minimum speed of 3 mph was chosen because the authors were attempting to find a more palatable ‘public health message’ that would neither daunt nor deter sedentary Americans, or because they, as exercise scientists, saw no significant physiological difference between the two intensities of expenditure. The issue was clouded further when the exercise prescription was re-phrased just two pages later:

“Adults who engage in moderate-intensity physical activity – ie, enough to expend approximately 200 calories per day – can expect many of the health benefits described herein.” And how might this exercise best be attained?...“To expend these [200] calories, about 30 minutes of moderate-intensity physical activity should be accumulated during the course of the day. One way to meet this standard is to walk 2 miles briskly.” **(Pate et al 1995 p 404)**

Of course, to walk 2 miles in 30 minutes one must, inescapably, walk not at 3 mph, but at 4 mph. Walking at 3 mph increases energy expenditure to just over 3 METS or about 120 kcals in 30 minutes **(Ainsworth et al 1993 and 2000)**, far fewer than the 200 kcals/30 minutes recommended by the authors.

Thus, the underlying recommendation, at 4 mph was not only “very brisk” as described by Ainsworth et al 1993. It was almost at the >4 mph speed (intensity) which Morris felt able to include within his definition of vigorous activity with a training (threshold) effect capable of significantly reducing the risk of heart disease and death. **(Morris et al 1973 p 334)** A speed at only $\frac{3}{4}$ of this intensity (3 mph) would, according to Morris’ later studies, afford only diminished protection and then only among older (55 yr +) men, and would not therefore be appropriate as a single, generalised public health recommendation. **(Morris et al 1990 p 327)**

8.10.1 Focus on Adherence

The authors of Pate et al 1995 asserted that: “Low- to moderate-intensity physical activities are more likely to be continued than high-intensity activities.” **(Pate et al 1995 p 403)** However, only a single citation was given to support this claim and it came from

the work of Michael Pollock, a co-author of Pate et al 1995. This study (**Pollock M 1988**) stemmed largely from the author's own short-term, organised exercise programmes administered to small groups of men. In most cases adherence among the men was highest when they were asked to perform fairly vigorous exercises (most commonly brisk walking or jogging) at durations of well under 1 hr. Pollock wrote: "Thus, for long-term adherence to training, intensity should be sufficient to elicit and maintain a training effect but not so extreme as to be a deterrent." (**op cit p 267**) Thus, this one cited study appeared not to support 'low-to moderate-intensity physical activities', but rather activities of higher 'training intensity'.

Nevertheless, the authors of Pate et al (which, after all, included Morris himself) appeared intent on pressing their public health message that it was unnecessary to sustain vigorous intensity activity to achieve important physiological results. Indeed they implicitly criticised the prevailing public health prescription for vigorous exercise as an unintended deterrent to population attributable improvements to the nation's health. They said:

"The current low-participation rate may be due in part to the misperception of many people that to reap health benefits they must engage in vigorous, continuous exercise. The scientific evidence clearly demonstrates that regular, moderate intensity physical activity provides substantial health benefits. After review of physiological, epidemiologic, and clinical evidence, an expert panel formulated the following recommendation: Every US Adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week." (**Pate et al 1995 p 404**)

While the content was simple, its message amounted, its authors' insisted (without apparent irony or conscious hyperbole) to a new health 'paradigm': "The new recommendation extends the traditional exercise-fitness model to a broader physical activity-health paradigm." (**op cit p 405**)

Thus, the total volume of physical activity, not the vigorous threshold intensity at which it is performed, was the key public health prescription. What then should be done with the old and allegedly (from an adherence or compliance perspective) detrimental vigorous activity public health prescription of 20 minutes of 6 MET activity for at least three days a week? The authors appeared to be unwilling to promote both moderate and vigorous prescriptions as parallel and equal options depending upon individual predilection. They asserted: "This article builds on existing recommendations, including

Healthy People 2000.” **(op cit p 403)** But, just as the CDC, ACSM and AHA had done, Pate and colleagues simply did not acknowledge the dual moderate and vigorous targets clearly proposed by Healthy People 2000. Instead they focused on the moderate target alone.

Further, Pate and colleagues suggested, on the one hand, that their moderate recommendation “...is intended to complement, not supersede, previous exercise recommendations”. **(op cit p 404)** Yet, they argued that the old vigorous activity recommendation was an exercise prescription “based on scientific studies that investigated dose-response improvements in performance training, especially the effects of endurance exercise training on maximal aerobic training” **(op cit p 404)** Thus, in simple terms, such a recommendation had focused on the kind of ‘performance training regime’ that a physical education teacher, coach, or at a higher scientific level, an exercise physiologist might impose on elite athletes to improve their competitive medal chances. In effect, this was inappropriate advice, they appeared to argue, for public health dissemination to ordinary and often sedentary people to help them reduce their risk of heart attacks and improve their healthy longevity in general.

The vigorous guidelines were not, however, wholly ineffective and inappropriate for this latter public health role:

“Although the earlier exercise recommendations were based on documented improvements in fitness, they probably provide most of the disease prevention benefits associated with an increase in physical activity. However, it now appears that the majority of these health benefits can be gained by performing moderate-intensity physical activities outside of formal exercise programs.” **(op cit p 405)**

It would appear, therefore, that the old vigorous recommendations, allegedly devised simply to improve fitness and ‘performance training’, actually provided, in addition, ‘most’ of the public health disease prevention benefits that were being sought. By comparison, the newly advocated moderate recommendations could only produce the ‘majority’ of these health benefits.

Could it be, therefore, that with this last description the authors were acknowledging the scientific/medical limitations of the moderate activity recommendations they were nonetheless proposing to make official US government public health policy? Was their decision based, on a social ‘perception’ and assessment reliant upon relatively little

evidence, that moderate physical activity guidelines would be more frequently taken up and adhered to by the many Americans who needed them most: those who were sedentary or increasingly inactive to whom vigorous exercise was, and would remain, anathema?

The authors emphasised that vigorous activity was somehow confined, or at least linked to rigorous and regimented 'formal exercise programs', whereas their new 'physical activity-health paradigm' of moderate activities could be incorporated easily into 'lifestyle' health improvements such as accumulated walking and stair climbing throughout the day. Pate and colleagues said:

"The recommendation is distinct in two important ways. First, the health benefits of moderate-intensity physical activity are emphasized. Second, accumulation of physical activity in intermittent, short bouts is considered an appropriate approach to achieving the activity goal. The unique elements of the recommendation are based on mounting evidence indicating the health benefits of physical activity are linked principally to the total amount of physical activity performed. This evidence suggests that the amount of activity is more important than the specific manner in which the activity is performed (ie, mode, intensity or duration of the activity bouts)."

(op cit p 405)

The concept of accumulating short-bouts-of-any-activity during the day to achieve 'health benefits' appears to have been very important to the authors' public health concept. They judged that the American public would not adhere to, indeed were deterred by, strenuous and regulated 'vigorous exercise programs', as they described them. However, by their own admission, the authors conceded: "A lack of time is the most commonly cited barrier to participation in physical activity." **(op cit p 403 and Pollock M 1988 p 267)** Yet, their own preferred '30 minute brisk walk' prescription must, by this analysis, have seemed relatively unattractive since at least 150 minutes (2 ½ hrs) a week over, at least, 5 separate days would be needed to achieve their physical activity goal – compared to the substantially shorter 1 hour/week demanded by the previous vigorous exercise recommendation needing just 3 bouts of 20 minutes to reach the same weekly target. Thus, to make their new, and time consuming, moderate activity programme appear palatable, it needed to be achieved, virtually without conscious effort, by accumulating a series of subtle, almost seamless lifestyle changes into daily energy expenditure.

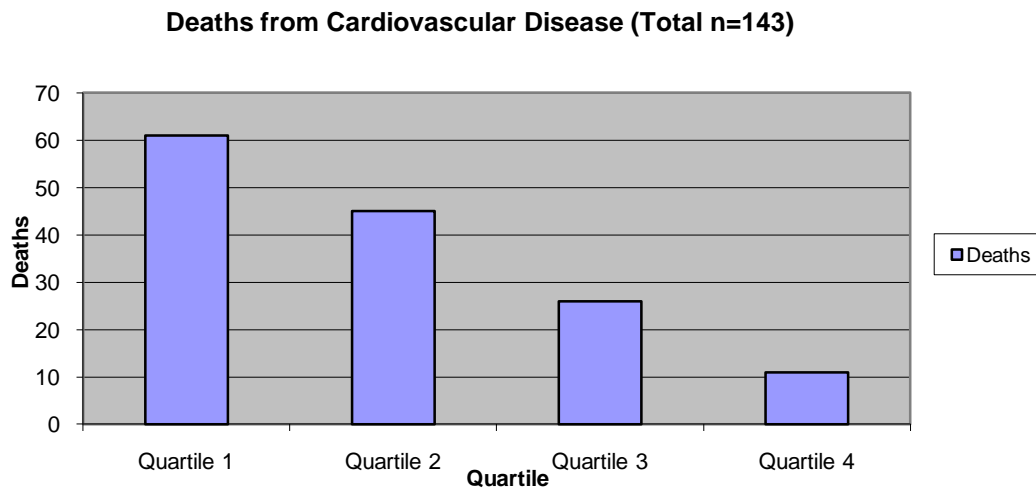
8.10.2 Volume versus Intensity

The authors repeated that the total volume of activity or energy expenditure was the key public issue – and not the intensity and/or uninterrupted duration of the effort:

“The health benefits of physical activity appear to accrue in approximate proportion to the total amount of activity performed, measured as either caloric expenditure or minutes of physical activity.” **(op cit p 405)**

To support this assertion they produced a composite graph of six leading epidemiological investigations **(op cit p 405)** showing the association between cardiovascular mortality risk and ‘level of fitness or activity’. **(Paffenbarger et al 1993, Morris et al 1990, Blair et al 1989, Leon et al 1987, Ekelund et al 1988, and Sandvik et al 1993)** With the exception of **Sandvik et al 1993**, all of those studies have been examined and reported upon here earlier, with the conclusion that only two of the studies **(Blair et al 1989 and Leon et al 1987)** made a strong case for the positive impact of relatively small amounts of moderate activity (or fitness) on mortality risk reduction. The rest, and most notably **Morris et al 1990**, saw a significant, indeed primary role for fitness/vigorous activity (threshold intensity) in conferring protection from cardiovascular or all cause mortality, with light-to-moderate levels of activity or fitness being far less beneficial, if effective at all.

To avoid repetition, but to underline the argument that the virtues of modest and moderate activity/fitness had not been proven, the simple mortality results are given below **(Figure 8.8)** for the **Sandvik et al 1993** study which was published in the *New England Journal of Medicine (NEJM)*. The authors studied 1,960 Norwegian men aged 40 to 59 using an exercise bicycle at baseline to test and divide the men into fitness quartiles. The study began in 1972 and, after average follow-up of nearly 16 years, 143 had died from cardiovascular causes – ie, the cause of death most closely associated with physical activity and cardio-respiratory fitness. **(Sandvik et al p 533)** Deaths by quartile were: (quartile 4 fittest)

Figure 8.8

Source **Sandvik et al (1993)** Quartile 4 fittest

The recorded deaths from all causes including cardiovascular disease (n=271) showed a similar pattern: 106, 77, 64, and 24, respectively as above.

So striking was the low death rate in quartile 4 that the authors chose to comment on the findings which were at such variance to the curvilinear and asymptotic gradient reported by Blair et al in 1989 which showed the steepest reduction in mortality between the least fit and the next least fit quintile. To the contrary Sandvik and colleagues saw the steepest decline among the fittest:

“We also observed a marked difference in mortality from cardiovascular causes between the subjects with intermediate levels of physical fitness (quartiles 2 and 3) and those with high levels (quartile 4) This finding would have remained undetected if our cohort had been followed for only 10 years as was the case in previous studies.” **(Sandvik et al 1993 p 535)**

Among those ‘previous studies’ cited was **Blair et al 1989** where the average length of follow up was just over eight years. Sandvik and colleagues described their finding as a “strikingly low overall mortality in the men from the highest fitness quartile as compared with those in the other three quartiles”. They suggested the reason remained obscure, and suggested the result “warranted further study”. **(Sandvik et al 1993 p 536)**

8.10.3 Promulgating a New Public Health Message

Pate and colleagues turned finally to what they called a 'Call to Action', aimed at getting clinicians and public health practitioners to put the new public health message across, even though they admitted, in the time honoured way, that more research on the health effects of differing physical activities was required:

“Although more research is needed to better elucidate the health effects of moderate- vs high-intensity activity and intermittent vs continuous activity, clinicians and public health practitioners must rely on the most reasonable interpretation of existing data to guide their actions. We believe that the most reasonable interpretations of the currently available data is that (1) caloric expenditure and total time of physical activity are associated with reduced cardiovascular disease and incidence of mortality; (2) there is a dose-response relationship for this association; (3) regular moderate physical activity provides substantial health benefits; and (4) intermittent bouts of physical activity, as short as 8 to 10 minutes, totalling 30 minutes or more on most days provide beneficial health and fitness effects.” **(Pate et al p 405)**

Accordingly, the public health community would need to expand and strengthen its leadership role. In particular the authors, while representing the CDC and ACSM, paid special appreciation to the American Heart Association for its 'leading' and 'crucial' role in promoting the public health message for physical activity. **(op cit p 405)**

8.10.4 Conclusion to Pate et al 1995

Pate and colleagues ended on a fervent note, encouraging inactive Americans to discard their feared yoke of 'regimented vigorous exercise', in order to embrace (and enjoy) healthy, 'lifestyle' activities of an accumulated, moderate kind:

“If Americans who lead sedentary lives would adopt a more active lifestyle, there would be enormous benefit to the public's health and to individual well-being. An active lifestyle does not require a regimented, vigorous exercise program. Instead, small changes that increase daily physical activity will enable individuals to reduce their risk of chronic disease and may contribute to enhanced quality of life.” **(op cit p 406)**

Finally, it might be asked why Jeremy Morris, the lone European expert chosen for the panel, would have lent his name to the report's strong advocacy of moderate, accumulated physical activity when his own investigations, consistently over many years, had demonstrated that regular vigorous activity was crucial to reduction of heart attack deaths among his British cohorts, and that accumulated moderate activity was of little, or no value. "I was just exhausted by the end and a victim of group psychology," he said. **(personal communication with JN Morris, London December 2006)** However, Morris did add the observation, as he had done in his published work **(Morris et al 1990, Morris JN 1992)** that it was likely that his British cohort was at baseline, and continued to be, fitter than the American cohorts of Paffenbarger or Blair. This might explain why the British civil servants did not significantly respond (with reduced cardiovascular mortality) to moderate intensity activities unless (and only weakly) they were 55 yrs and older, or they combined the 'duration and pace' of fairly brisk walking for no less than 7 hours a week **(Morris et al 1990 Table 1 p 326)**.

8.10.5 Contemporary Criticism of Pate et al 1995: 'Scientific Integrity – Public Policy Sense?'

Morris was not alone in his scepticism about the new moderate 'physical activity-health paradigm'. Six months after the publication of **Pate et al 1995**, the Journal of the American Medical Association (**JAMA**) published several letters in critical reply. One came from Paul Williams, an exercise scientist and biostatistician at the Lawrence Berkeley Laboratory in California **(Williams PT 1995)**. He challenged the authors' central argument (based on **Blair et al 1989**) that much greater health benefits (Williams calculated a 12 fold increase) accrued from increasing physical activity status in sedentary individuals compared with physically active individuals. "I am unaware of any data to support this substantial disparity in benefit." **(op cit p 533)** Williams was particularly critical of the portrayal and analysis in **Pate et al 1995** of the composite graph of 6 epidemiological studies discussed earlier. "As originally drawn, the graph diminishes the precipitous drop in relative risk between the penultimate and highest levels of physical fitness in the studies by Morris et al and Ekkelund et al." **(Williams PT p 533)** He further suggested that a recent and relevant study published in *Circulation* (the journal of the American Heart Association) had not been included in the analysis. **(Rodriguez et al 1994)** After including this paper, and re-plotting the composite graph in **Pate et al 1995**, Williams produced a revised version of the graph, from which he concluded: "The average of the six studies and the incremental decreases in risk from

going from one activity level to the next yield little evidence that health improvements diminish at higher levels of physical activity or fitness.” **(Williams PT 1995 p 534)**

While Williams focused on the curvilinear claim by Blair of health benefits, another investigator, Richard Winett, professor of health psychology at Virginia Tech University directly challenged the central claim that a modest volume of moderate activity could medically rival, and thus should replace, vigorous activity as the keystone public health recommendation. This assumption, he suggested, rested on ‘disappointing outcomes’ (presumably poor adherence to existing vigorous guidelines) and misinterpretation of the available scientific evidence:

“Partly in response to disappointing outcomes, and partly based on empirical studies, guidelines for activity and exercise have been reduced to the accumulation of moderate activity five times per week. While seemingly well-intentioned, these guidelines and the public health message they deliver may be problematic and potentially counterproductive from both scientific and public policy perspectives in several ways....Exercise science does not support the interchangeability of frequency, duration and intensity of exercise.” **(Winett RA 1995 p 534)**

Winett cited the latest paper from Paffenbarger’s *Harvard Alumni Study* **(Lee et al 1995)** discussed earlier) which clearly saw that vigorous activities, not sheer caloric expenditure (volume and duration) were critical for (mortality) risk reduction. Winett also challenged the assumption that the disappointing outcomes – namely Americans’ failure to become regularly active – could be solved with a ‘softer but longer’ option.

“Note also while the higher-intensity protocol does require more effort and commitment, it is more cost-efficient, requiring less time to produce better outcomes” Further: “Because promoting exercise has proved to be a daunting task, one response has been to promote the barest minimum of activity.” **(Winett RA 1995 p 535)**

He recognised that many sedentary individuals would be both unlikely and unwise suddenly to lunge into vigorous activities – but that was no reason for banishing higher intensity exercise from an optimum role in public health advice. Thus, moderate activities should, he argued, be the first step:

“As a starting point, this may be reasonable. However, prevention messages emphasizing health, fitness, and strength benefits can accrue from more efficient programs that do require some effort and commitment,

show more scientific integrity and may make more public policy sense.” (**op cit p 535**)

8.11 NIH Consensus Conference December 1995: Physical Activity and Cardiovascular Health

Less than a year after the publication of the CDC/ASCM recommendations (**Pate et al 1995**) the US Government funded National Institutes of Health (NIH) convened a similar consensus conference in December 1995. It focused more narrowly on physical activity and cardiovascular health (rather than upon public health more broadly) because it was organised primarily by the National Heart, Blood and Lung Institute (NHLBI) under the wider umbrella of the NIH itself.

Unpublished background documents obtained from the NHLBI under the US Freedom of Information Act (**USFOIA**) – which help reveal the ways that the conference was first conceived and then how its construction and conclusions were heavily influenced by Steven Blair and other ‘moderate enthusiasts and activists’ – will be used here and examined in greater depth shortly in Chapter 10.

The consensus statement from the conference (**NIH 1996**), also published in the *Journal of the American Medical Association* (**JAMA**), came to the same broad conclusion as Pate et al 1995: that moderate intensity activity should be the primary message – the cornerstone – of public health recommendations to reduce the prevalence of heart disease in the United States among a population who were often disturbingly sedentary or only irregularly active. The statement said:

“We recommend that all children and adults should set a long-term goal to accumulate at least 30 minutes or more of moderate-intensity physical activity on most, or preferably all, days of the week.” (**NIH 1996 p 243**)

Also, in words that echoed **Pate et al 1995**, the NIH statement blamed previous emphasis upon – or at least the common, popular ‘misperception’ about – the exclusive virtues of vigorous activity (and this subsequent deterrent effect) for the rising rates of inactivity among Americans:

“Current low rates of regular activity in Americans may be partially due to the misperception of many that vigorous, continuous exercise is necessary to reap health benefits. Many people, for example, fail to appreciate walking

as ‘exercise’ or to recognize the substantial benefits of short bouts (at least 10 minutes) of moderate-level activity.” **(op cit p 243)**

Explanation of this common language, even down to repetition of the unusual, if not idiosyncratic word ‘misperception’ (as opposed to the arguably more common, misconception) may lie with the fact that both bodies shared prominent personnel. Most of the 26 strong ‘planning committee’ for the NIH conference came, unsurprisingly, from within the the National Heart, Lung and Blood Institute – as well as from other NIH institutes, including those for Aging, Arthritis, Child Health, Diabetes and Women’s Health. The CDC and other US Government Health bodies were also represented. However, among the 5 non-US Government members chosen were: Steven Blair, Russell Pate and Ralph Paffenbarger. They would have had strong influence over the choice of the 27 expert investigators chosen to present papers to the conference, and they each presented papers themselves. (NB Paffenbarger’s was actually spoken by his frequent co-author, I-Min Lee. **(Lee and Paffenbarger 1995)**)

Further, when addressing the question of the best intensity of physical activity, the NIH Consensus Statement appeared, at first glance, entirely to endorse the new moderate intensity public health recommendation elucidated by Pate et al 1995:

“Activity that reduces CVD risk factors and confers many other health benefits does not require a structured or vigorous exercise program. The majority of benefits of physical activity can be gained by performing moderate-intensity activities” **(NIH 1996 pp 242-3)**

However, unlike Pate et al 1995, the NIH Consensus Statement did not overwhelmingly endorse a so-called ‘physical activity-health paradigm’. Instead it was more equivocal and circumspect in not rejecting all advantages of vigorous activity. For example:

“The amount or type of physical activity needed for health benefits or optimal health is a concern due to limited time and competing activities for most Americans. The amount and types of physical activity that are needed to prevent disease and promote health must, therefore, be clearly communicated, and effective strategies must be developed to promote physical activity to the public.” **(op cit p 243)**

Indeed, on the same page, the consensus statement appeared at least to recognise that if Americans perceived ‘limited time’ as a hindrance to exercise, then more intense, time-efficient vigorous activities could appear an attractively swift option:

“Higher intensity or longer-duration activities could be performed approximately 3 times weekly, but low-intensity or shorter-duration activities should be performed more often to achieve cardiovascular benefits.” **(op cit p 243)**

The consensus statement strayed even further away from the new moderate ‘orthodoxy’ with: “Some evidence suggests lowered mortality with more vigorous activity, but further research is needed to more specifically define safe and effective levels.” **(op cit p 243)**

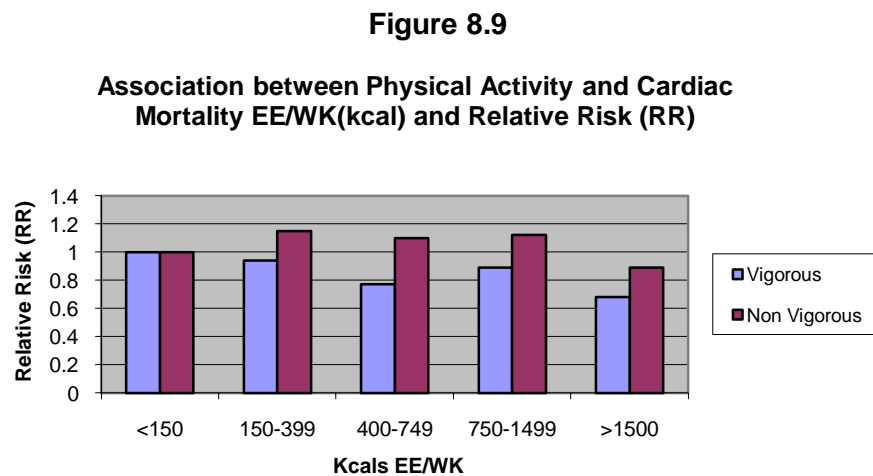
8.11.1 Construction and Composition of the Consensus Panel

Why such apparent ambivalence? Two reasons immediately suggest themselves. First, the 13 member consensus panel, which actually drew up the document and “...resolved conflicting recommendations and released a revised statement at the end of the conference”, **(op cit p 241)** was not drawn from the usual ranks of physical activity investigators. To the contrary, documents obtained from the National Heart, Lung and Blood Institute of the NIH show that its rules barred from its consensus panels any person who held “strong advocacy positions”. **(NHLBI 04/21/95 bundle p 7)** Instead the panel was drawn from a broader range of clinicians and investigators from allied but disparate disciplines including epidemiology, pediatric psychology, biostatistics and cardiology. Indeed one individual on the panel was a senior vice president of a bank in North Carolina with no evident medical or academic qualifications. Neither Blair nor Pate and Paffenbarger, therefore, would have been directly involved in the consensus statement’s final draft.

8.11.2 I-Min Lee’s Presentation (Lee and Paffenbarger 1995)

Further documents elicited for this dissertation from the NIH Consensus Conference (under the **USFOIA**) show that the issue of exercise intensity was addressed specifically in a paper presented by I-Min Lee **(Lee and Paffenbarger 1995)**. It consisted of a brief literature review and was also an update to her recently published paper with Paffenbarger, which has already been examined here in depth **(Lee et al 1995)**. This review and update was again clearly titled, to tackle the vexed issue of intensity of energy expenditure directly: *Is Vigorous Physical Activity Necessary to Reduce the Risk of Cardiovascular Disease?* **(NHLBI bundle 11/08/95 p 49-52)**. Lee chose in the review section to include some (but not all) of the investigating teams

examined in this chapter, namely: Morris, Slattery, Shaper, Leon, Lakka, and her own work with Paffenbarger. As we have seen, most of these studies (with the exception of Leon et al 1987) saw the clearest reductions in cardiac risk in the presence of vigorous intensity activity – not least her own study with Paffenbarger. **(Lee et al 1995)** Curiously, she chose not to mention that this, their most recent published work, had found significant all-cause mortality reduction only among Harvard alumni who practiced vigorous intensity leisure activities and none among those who only did non-vigorous activities. Instead, she presented new, ‘unpublished’ data from the study relating specifically to cardiac deaths where she suggested that the reductions seen with increasing amounts of vigorous activity ‘did not differ significantly’ from those from non-vigorous. **(Lee and Paffenbarger 1995 NHLB bundle 11/08/95 p 51)** This, in itself seemed incongruous since cardiac fatalities make up a large proportion of all-cause mortality and normally show an even greater statistical association with measures of physical activity (energy expenditure). However, Lee’s previously ‘unpublished’ cardiac data are reprinted in **Figure 8.9**:



Source: **Lee and Paffenbarger(1995)** (NHLBI bundle 11/08/95 p 51) Note: <150 kcals EE/WK is referent. 95% confidence intervals. Vigorous activity <150 kcal: referent, 150-399 kcals: 0.76-1.17, 400-749 kcals: 0.56-1.06, 750-1499 kcals: 0.63-1.26, >1500 kcals: 0.48-0.96 Non Vigorous activity <150 kcals: referent, 150-399 kcals: 0.82-1.61, 400-749 kcals: 0.79-1.53, 750-1499: 0.81-1.54, >1500kcals 0.64-1.23.

Lee’s interpretation of the review and new data led her to suggest: “In conclusion, based on the available data, it remains unclear whether it is the amount or intensity of physical activity that is important for a reduced cardiovascular risk.” **(op cit p 51)** Nevertheless, and in spite of the scientific uncertainty (which left the ‘vigorous hypothesis’ far from falsified) the balance of the NIH Consensus statement swung

finally to remain broadly in support of the new moderate intensity recommendation elucidated by **Pate et al 1995**.

“Moderate-intensity activity performed by previously sedentary individuals results in significant improvement in many health related outcomes. These moderate-intensity activities are more likely to be continued than are high-intensity activities.” (**NIH 1996 p 243**)

Room was left to broaden the public health appeal to include more vigorous activity for those already active – but the primary message still gave credence to the ‘Blair hypothesis’ that only modest health benefits could be gained by active people becoming even more active:

“People who currently meet the recommended minimal standards may derive additional health and fitness benefits from becoming more physically active or including more vigorous activities.” (**NIH 1996 p 243**) But in population terms, these improvements were still of relatively minor importance, and could not be guaranteed for each ‘parameter’ of cardiovascular risk:

“The most active individuals have lower cardiovascular morbidity and mortality rates than do those who are least active; however, much of the benefit appears to be accounted for by comparing the least active individuals to those who are moderately active. Further increases in the intensity or amount of activity produce further benefits in some, but not all, parameters of risk.” (**op cit p 243**)

8.11.3 Vigorous Intensity Exercise and Sudden Cardiac Death

Vigorous activities were also associated with a greater risk of physical harm, not merely from muscle and bone injuries. The consensus statement said:

“A more serious but rare complication of activity is myocardial infarction or sudden cardiac death.” And yet the consensus panel’s clear verdict on the balance of risks and benefits was still in favour of encouraging vigorous intensity activities for the minority who might embrace them: “Although persons who engage in vigorous physical activity have a slight increase in risk of sudden cardiac death during activity, the health benefits outweigh this risk because of the large overall risk reduction.” (**op cit p 243**)

This upbeat advice even stretched, with only modest caution, to older people with quite poor cardiac profiles. Most adults would need no medical pre-testing or advice before starting a moderate-intensity physical activity programme:

“However those with known CVD and men over 40 years of age and women over 50 years with multiple cardiovascular risk factors who contemplate a program of vigorous activity should have a medical evaluation prior to initiating such a program.” **(op cit p 243)**

Even among recovering cardiac patients in rehabilitation programs “....both moderate and vigorous physical activity have been associated with reductions in fatal cardiac events, although the minimal or optimal level and duration of exercise required to achieve beneficial effects remains uncertain.” **(op cit p 244)**

8.11.4 Summary and Conclusion of the NIH Consensus Conference 1995

In summary, the primary advice of the NIH consensus panel – for adult Americans to accumulate 30 minutes of moderate activity on most, and preferably all, days of the week – left them broadly in line with the ‘physical activity-health paradigm’ first elucidated by Haskell at the CDC public health workshop **(Haskell et al 1985)**, emphatically strengthened by Blair **(Blair et al 1989)**, repeated after 1990 in successive guidelines suggested by the AHA and ASCSM, and finally culminating in the ‘paradigm’s formal declaration in the 1995 joint CDC/ACSM recommendations **(Pate et al 1995)**.

Overall, when strong, conflicting evidence favouring the benefits of vigorous activity was put forward, it was often played down or discounted by the consensus panel. **(Morris et al 1990, Morris et al 1992, Paffenbarger et al 1993, Lee et al 1995)**, or misinterpreted **(Ekelund et al 1988 and Sandvik et al 1993)**

8.12 Blair et al 1996

Evidence of this apparent anomaly can further be seen within the deliberations of the NIH consensus conference, itself. One of the papers given at the conference, by Steven Blair **(Blair SN 1995)** was subsequently expanded and published **(Blair et al 1996)** – again in the *Journal of the American Medical Association (JAMA)*. It was, for the most part an extension and updating of Blair and colleagues’ highly influential data on physical activity and all cause mortality **(Blair et al 1989)** drawn from their cohort in

the Aerobics Center Longitudinal Study in which 10,224 men and 3,120 women undertook baseline treadmill aerobic fitness tests between 1970 and 1981. However, there were at least two important changes in the later study (**Blair et al 1996**). First, the cohort size was greatly expanded to a total of 25,341 men and 7,080 women with baseline tests extending from 1970 to 1989. Even though the 'average' follow-up time did not change (in both reported studies just over 8 years), the distribution of the follow-up time curve would have looked very different in the later study (**Blair et al 1996**) because the first participants tested in 1970 remained (unless deceased) in the extended study, while the later entrants (in the late 1980s) would have had much shorter periods of follow-up time, since surveillance was terminated at the end of 1989. **(op cit pp 205-206).**

Second, in the earlier study, the sole outcome objective was to study the relationship between physical fitness and all-cause mortality. Hence, and presumably to eliminate confounding variables: "...at baseline, all patients had no personal history of heart attack, hypertension, stroke, or diabetes; no resting electrocardiographic (ECG) abnormalities; and no abnormalities on the exercise ECG." (**Blair et al 1989 p 2395**) In direct contrast, the extended cohort in the later study was described thus:

"Most study participants were apparently healthy at baseline, although 1866 men and 350 women had abnormal resting or exercise electrocardiogram (ECG), and 4,802 men and 958 women reported a history of 1 or more of the following chronic illnesses at baseline: myocardial infarction [heart attack], stroke, hypertension, diabetes mellitus or cancer." (**Blair et al 1996 p 206**).

The reason that exclusion of these chronically ill participants was deliberately avoided was that Blair and his team had decided to widen the study to examine the association between fitness and all-cause mortality (as well as death from cardiovascular disease) quite specifically in the presence of these (and other, such as smoking and high cholesterol) mortality risk factors. **(op cit p 205)**

As will be discussed at greater length in Chapter 10, Blair and colleagues had previously presented data (**Blair et al 1989**) which found that decreases in mortality came rapidly when the least fit first quintile were compared with the next least fit quintile, whereas gains at the higher spectra of fitness were much more modest – a very concave curvilinear relationship which strongly underpinned the argument for replacing vigorous intensity (higher fitness) public health recommendations with ones

favouring modest amounts of very moderate activity (the 30 minute 'brisk' walk) – especially for America's sedentary or irregularly active majority. (**Blair et al 1989**)

However, in Blair et al 1996 a very different picture emerged. Benefits from increased fitness at baseline were no longer found overwhelmingly at follow up in decreased mortality between the least fit and the next least fit group – on a curvilinear slope. This time the slope was more linear, with mortality falling almost equally as fitness increased. Note that on this occasion the authors chose to divide the population into uneven groups (low, moderate, high) with the first group containing the 20.1% least fit, and the medium and high groups containing 42% and 37.9%, respectively for men, and for women, 18.8%, 40.6%, and 40.6% respectively. The 'dose-response' of fitness level to all-cause mortality in both men and women can be seen overleaf in **Table 8.2**:

Table 8.2
Baseline Fitness as a Predictor of All-Cause Mortality among Men and Women

	Men		Women	
Characteristic	Survivors (n = 24,740)	Decedents (n = 601)	Survivors (n = 6991)	Decedents (n=89)
Fitness %				
Low	20.1	41.6	18.8	44.9
Moderate	42.0	39.1	40.6	33.7
High	37.9	19.3	40.6	21.3

Source: **Blair et al 1996 Table 1 p 206**

Mortality reduction was approximately linear from least fit, to fittest in both genders. Indeed, toward the end of the comment section of their report, Blair and colleagues apparently endorsed a straight forward dose-response relationship between fitness and mortality, with the fittest tertile suffering significantly fewer fatalities:

“Our study underscores the strong, graded, and independent association of fitness with CVD and all-cause mortality.” (**Blair et al 1996 p 210**) Further, Blair and colleagues had looked specifically at the remarkable death protection afforded to the ‘high-fit’ men and women – even when they carried multiple risk factors (two or three including smoking, high blood pressure and cholesterol). “High fit persons with multiple predictors had lower death rates than low-fit persons who had no other predictors.” (**op cit p 210**) The authors did not (and could not) make this claim for those in the ‘moderate-fit’ category, because their data simply did not support it. To the contrary, the ‘moderate-fit’ men with multiple risk factors had a death rate more than twice as high as the ‘low-fit’ men who had no risk factors (**op cit p 210 Figure 3**) . As we have seen above (in this chapter) it was observed by **Sandvik et al 1993** that such a strong linear association (not curvilinear) only began fully to emerge in their Finnish study after lengthy (16 years) follow-up. This might then explain why the curvilinear association seen in **Blair et al 1989** was not repeated in this, his extended follow-up study. The ‘average’ length of follow up may have stayed roughly the same in the two studies (just over 8 years), but the follow up time of surviving participants from the earlier years (1970s) would have been extended to the year 1989 in Blair et al 1996.

Logically, therefore, the public health message from Blair et al 1996 could more reasonably have been: ‘The fitter you are, the greater your protection will be from early mortality, especially if you carry the burden of other risk factors.’ Yet, in their conclusion and in the abstract of their report, Blair and colleagues chose to emphasise that ‘moderate fitness’ was protective, without mentioning the further clear and linear improvement found with higher fitness, especially among individuals carrying several risk factors. They advised merely, therefore that:

“Moderate fitness seems to protect against the influence of these other predictors on mortality. Physicians should encourage sedentary patients to become physically active and thereby reduce the risk of premature mortality.” (**op cit p 205 and p 210**)

8.13 Chapter 8 Summary

It had now been more than two decades since Kenneth Powell convened the CDC physical activity workshop with the lament (quoting Milton Terris) that: “physical fitness and physical education have no respected place in the American public health movement.” (**Powell and Paffenbarger 1985 p 118**). Now, as this chapter has explored, with their moderate ‘physical activity-health paradigm’ fully elucidated and

supported by the influential American Heart Association, American Science of Sports Medicine, Centers for Disease Control and the National Institutes of Health , the American physical activity fraternity were well positioned to ensure that the upcoming US Surgeon General's report on physical activity and health would provide the 'right' public health prescription for the American people. It is to the US Surgeon General's report that we now turn to examine it in detail.

Chapter 9: The US Surgeon General's Report

9 Introduction

This chapter examines how, in spite of incomplete and conflicting evidence, the *US Surgeon General's Report on Physical Activity and Health* declared an 'emerging consensus' supporting the new moderate activity 'paradigm' that had been 'constructed' in the years preceding its publication in July 1996. It further examines, chapter-by-chapter, how evidence was selectively chosen, presented, interpreted, distorted – and at times inexplicably ignored in ways designed apparently to support and defend the US government's public health policy decision to shift guideline emphasis entirely away from vigorous intensity activities in favour of activities of moderate intensity, but of longer duration. It focuses on the extensive coverage given to two diseases (cardiovascular disease and cancer) to the relative exclusion of other health outcomes and the roles played by the American Heart Association and Steven Blair and his close colleagues in shaping its construction.

As a result the overwhelming message of the 300 page public health document was to over-play the value of relatively small amounts ($\approx 1,000$ kcals/wk) of moderate intensity activity. That value was exaggerated not only in the specific health benefits that this kind of physical activity might provide, but also by implicit and explicit estimation of the greater long-term adherence to the 'moderate recommendation' by an increasing percentage of the American public. To emphasise this moderate message, the Report went further to minimise the importance of more vigorous activities by suggesting that many people disliked them and, in any event, total volume of activity (kcals expended) rather than its intensity (kcals/min) was the key to health benefits. Thus, vigorous activity was 'demoted' and most frequently portrayed as an optional and largely unnecessary goal – especially for the majority of Americans who were sedentary or only occasionally active and who would be least likely, it was argued, to maintain adherence to such an arduous regime. At the same time, little, if any, substantial evidence was provided to support what seemed to be the plausible assumption that less strenuous activity might be more attractive, even if the time and frequency demanded was substantially greater for a population with a common perception that it already lacked sufficient time for leisure time physical activity pursuits.

These interpretations were apparently well intentioned, but nevertheless socially constructed from assumptions (whether implicit or explicit) that caused the scientific

evidence to be selectively chosen and misinterpreted. The Report's fundamental conclusion and recommendation became all the more problematic because it emerged as a simplified, and indeed, simplistic single message – 5 or more brisk walks for 30 minutes each week – which rapidly became the largely unchallenged public health mantra not only in the United States, but throughout Europe and the rest of the developed world.

In many other respects, however, the Report makes a thorough and un-contentious attempt to assess, interpret and explain the broad and beneficial 'physiologic' impact of all physical activity on human health. Also, in the second chapter (Chapter 2), which is discussed only briefly here, it provided an excellent overview of the history and terminology of the study of physical activity and of previous public health recommendations. Above all, the Report's publication from the US Surgeon General's office has ensured that greater prominence and importance have been given to the role of physical activity as a primary tool of public health policy in the United States and elsewhere. Much of the credit for that success appears to belong to Dr Adele Franks, a public health physician at the Centers for Disease Control and Prevention who was drafted in to work alongside Steven Blair to ensure that the Report, in its final form, was approved after inter-agency scrutiny, for publication. **(personal communication with SN Blair, London, September 2007; A Franks, Northampton Massachusetts May 2007, T Bazzarre, Princeton, New Jersey May 2007)**

FOIA Request: Absence of Background 'Grey Matter' Material for Triangulation

One of the greatest limitations of this study has been the absence of any of the unpublished policy materials – the 'grey matter' of memos, drafts and other background documents – that were written during the planning, drafting, production and editing of the US Surgeon General's Report. Repeated requests via the formal US Freedom of Information Act Procedure **(US FOIA)** yielded not a scrap of evidence (unlike a similar request for background data surrounding and relating to the National Institutes of Health Consensus Conference (December 1995) where a substantial amount of information was obtained).

There is strong evidence to suggest that all of these unpublished policy documents were destroyed during an internal reorganisation at the Centers for Disease Control and Prevention (CDC) in Atlanta shortly after the Report was published. Michael Pratt, the most senior official still at the CDC who played a role in the Report's production said:

“I’m afraid pretty much all of that stuff was trashed years ago. We have file cabinets, but they only contain, as far as I am aware, copies of the cited scientific journal reports that went into formation of the Surgeon General’s report. One of the biggest reasons that records don’t survive is that the division of nutrition and physical activity did not exist when the Report was prepared and published. So internal re-organisation meant lots of things were thrown away.” **(personal communication with Michael Pratt January 2007)**

The Report was prepared and published before the era of email communication, and the internet was only upon the cusp with the introduction of Windows 1995, the software which fully ushered computer technology into everyday life. If floppy discs of information were made, these have apparently been lost too, along with the hard drives of old desktops long ago discarded in a decade still coming to terms with the new technology and the importance of keeping its electronic historical records.

Dr Pratt’s opinion was confirmed by Adele Franks, the scientific editor of the Report, who oversaw all the later steps of its preparation and publication. On a visit to the CDC in the Spring of 2007 she kindly made renewed attempts to uncover any of this background data, and was again, unsuccessful. She did, however, find the ‘file cabinets’ described by Dr Pratt and provided this author with an extensive list of their contents. Unfortunately, they did contain only the published scientific journal reports that the authors of the Report relied upon. This catalogue cannot directly reveal which documents weighed heavily (or not) in influencing the key elements of the Report’s findings. But it can, at least indicate which key documents are no longer stored, and which were therefore probably never gathered or evaluated in the Report’s deliberation. Thus, it has been all the more important extensively to interview the key individuals who played the most influential roles in the Report’s planning, preparation and publication, not least its two editors, Adele Franks and Steven Blair.

Haapanen et al 1996

Further contemporary evidence had begun to emerge from a group of well respected Finnish investigators that the scientific evidence in 1996 remained conflicting, uncertain and/or incomplete. The Finnish team, led by Haapanen and Vuori, published their concerns, not in an obscure European journal, but in the American Journal of Epidemiology in early May 1996, while the US Surgeon General’s Report, published in late July, was still in preparation.

Their assessment came in the introduction to their own 10 year follow-up study (**Haapanen et al 1996**) on the association between leisure time physical activity, all-cause, and cardiovascular disease mortality among a cohort of 1,072 Finnish men aged 35-63. The authors commented directly on how uncertain and conflicting was the epidemiologic literature on the relative importance of intensity, duration and total volume of energy expenditure on these health outcomes:

“Despite extensive evidence indicating an apparent protective effect of leisure time physical activity for both cardiovascular and all-cause mortality, the existing epidemiologic studies yield somewhat conflicting results about the nature of physical activity needed to achieve preventive effects against cardiovascular disease and all-cause mortality. Based on current knowledge, the relative contributions of the frequency, intensity, duration and type of physical activity in reducing the risk of cardiovascular diseases and death are difficult to determine. Some studies suggest that only rather high intensity exercise is effective (**Morris et al 1980, Morris et al 1990, Lakka et al 1994**), while others suggest that moderate activity is sufficient to reduce risk (**Leon et al 1987, Leon et al 1991, Paffenbarger et al 1986**). A similar discrepancy is found in studies concerning the association between physical fitness and coronary heart disease or total mortality. In some studies, there seems to be a consistent, graded relationship between physical fitness and mortality (**Lakka et al 1994, Ekelund et al 1988, Sandvik 1993**), while other studies [sic] show that the most significant difference in mortality risk seems to occur between the lowest and next lowest fitness categories.” (**Haapanen et al 1996 pp 870-71**)

In fact, **Leon et al 1991** was not a new cohort, but simply an extension of the **Leon et al 1987** study discussed at length earlier in Chapters 7 and 10. Furthermore, Haapanen and Vuori cited only a single study with this last concave, curvilinear and asymptotic evaluation: Blair et al 1989. They went on explicitly to underline this conflict and uncertainty:

“For this reason, more convincing data are needed to reveal the kind of physical activity required in terms of the type, intensity, and frequency of exercise sessions, as well as the total weekly energy expenditure in exercise, to achieve the preventative effects of physical activity on overall and cardiovascular disease mortality.” (**Haapanen et al 1996 pp 870-71**)

Thus Haapanen and colleagues appeared to suggest that no substantial revision of public health guidelines for physical activity would be wise and prudent until ‘more

convincing' data – not least on the importance of intensity – became available, from a more thorough and balanced literature review – and from new intervention and epidemiological studies.

9.1 Political/Public Health Policy Preamble: Moderate 'Intensity-Amount Level' Messages

That stark assessment of the continuing uncertainty within the 'intensity debate', was hardly reflected in the opening remarks which American politicians and public health policy makers chose to make and place prominently in the preamble to the US Surgeon General's Report. The then Secretary of Health and Human Services, Donna Shalala proclaimed that American scientists had, in the 1980s and 1990s, "made breakthrough findings about the health benefits of moderate-intensity activities such as walking, gardening and dancing." **(USSG 1996 p i) (emphasis added)** Shalala told Americans:

"A regular, preferably daily regimen of at least 30-45 minutes of brisk walking, bicycling, or even working around the house or yard will reduce your risks of developing coronary heart disease, hypertension, colon cancer, and diabetes." **(op cit p i)**

She did not entirely exclude more vigorous intensity activity from her exercise prescription, but she appeared to repeat the core argument of the 'moderate modernisers' that an extra daily dose of additional moderate activity would be, in terms of health improvement and disease reduction, equal too and indistinguishable from, the improved health profile of vigorous intensity activities. Thus total volume (kcal of expenditure) and not intensity of activity was the key to health benefits:

"And if you're already doing that, you should consider picking up the pace: this report says that people who are already physically active will benefit even more by increasing the intensity or duration of their activity." **(USSG 1996 p i)**

By this logic, therefore, Americans could choose equally between a shorter, intense jog – or a longer moderate walk – and achieve identical, additional health benefits because intensity and duration of physical activity were physiologically inter-changeable. Intensity, in and of itself, was not important.

This 'equal to and indistinguishable from' interpretation was echoed in a similar opening message from Dr David Satcher, director of the CDC (Centers for Disease Control and Prevention): Alluding to the 1996 Olympic Games, which were about to begin in Atlanta, he again re-assured Americans:

“The good news in this report is that we do not have to scale Olympian heights to achieve significant health benefits. We can improve the quality of our lives through a lifelong practice of moderate amounts of regular physical activity of moderate or vigorous intensity.” **(op cit p iii) (emphasis added)**

Intensity or duration, moderate or vigorous....both the Health Secretary and the director of the US Government’s most important public health body were telling Americans that, in effect, the intensity debate was over. American scientists had apparently proven that moderate intensity activity was every bit as good...in every respect.

It’s instructive, however, to note that Shalala and Satcher did not manage to agree on their terms of measurement – or at least their scriptwriters could not. Shalala used the relatively clear definition ‘moderate intensity’, while Satcher chose the ambiguous ‘moderate amounts’. The imprecision was compounded further by the acting Surgeon General, Dr Audrey Manley when she chose: “The good news in the report is that people can benefit from even moderate levels of physical activity.” **(op cit p v) (emphasis added)**

9.2 Chapter 1 of the Report: Introduction, Summary and Chapter Conclusions

Bearing in mind that the Report stretched to 300 pages, it was likely that the ‘executive report’ – of its introduction, summary and chapter conclusions (Chapter 1) would be the most that would be absorbed and communicated by the media and by most other methods of dissemination. It was here that the emphasis on the benefits of moderate activity – and the ‘unnecessary discomfort’ of more vigorous intensity activities – is most evident. The chapter’s opening paragraphs are therefore quoted at some length. Once again, the terms intensity, amount, and level are used with evident imprecision.

“This is the first Surgeon General’s report to address physical activity and health. The main message of this report is that Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily lives. Health benefits from physical activity are thus achievable for most Americans, including those who may dislike vigorous exercise and those who may have been previously discouraged by the difficulty of adhering to a program of vigorous exercise. For those who are already achieving regular moderate amounts of activity, additional benefits can be gained by further increases in activity level.” **(op cit p 3) (emphasis added)**

The argument that doing some physical activity is better for human health than being entirely sedentary was hardly contentious. But as we have seen, the claim that 'moderate amounts' produce substantial improvements was both uncertain and contentious on two grounds: First the terms 'amount' and 'substantial' lacked precise definition, implicitly assuming that the two components of amount – intensity and duration – were interchangeable. Second, as Haapanen and Vouri (**Haapanen et al 1996**) succinctly summarised, the most recent and authoritative evidence from epidemiologic studies remained uncertain, and indeed conflicting, in failing solidly to support Blair's ACLS data that the greatest health benefits were found between the least fit and those who were just a bit fitter – in essence, the primary evidence, from a single study (**Blair et al 1989**) that gave support for the 'moderate amount – substantial benefit' claim.

Indeed, Haapanen and Vouri did not cite, and thus may have submitted their article too early, to have had the advantage of seeing Paffenbarger's latest data from the Harvard Study (**Lee et al 1995**) indicating quite the opposite, and conflicting result: that without inclusion of some vigorous intensity 'strenuous' activity, no amount (total kcals of expenditure) of non-vigorous activity was significant in reducing all-cause mortality. However, the authors of the US Surgeon General's Report failed even to consider this crucial paper that was so central to the debate. This omission is inexplicable, not least because Paffenbarger was universally regarded as the American doyen of his field and Dr Lee, was his able and admired colleague and collaborator. Furthermore, the paper was published on April 19, 1995 in one of the two most influential and widely read American medical journals, the *Journal of the American Medical Association* (**JAMA**). Yet it did not appear in the text of, or in the references to, the US Surgeon General's Report, even though Lee herself served as one of the 'contributing authors' to the Report. What is more, other (and often less relevant) articles published after it, and in less prominent journals, were included and referenced in the Report. For example, in the substantive Chapter 4 of the Report (*Effects of Physical Activity on Health and Disease*) alone, no fewer than 39 articles published in 1995 were cited and at least 8 published in 1996, not least Oliveria et al 1996, a paper co-authored by Steven Blair. See also for example: Ching et al 1996; Kirchner et al 1996.

The claim that some Americans might dislike and also find difficulty in adhering to a 'vigorous activity program' also needs further examination. No doubt some Americans disliked vigorous activity. But where was the evidence that they greatly preferred moderate activity and would adhere to such programs or 'lifestyles' more conscientiously? The contemporary US Government Surveys discussed in the previous

chapter (Chapter 8) showed similar results of regular adherence to both intensities. Moreover, the US Surgeon General's Report also had the thorny problem of addressing the results of the biggest, longest lasting and most authoritative intervention trial on physical activity ever constructed in the United States, the results of which had only just been published the previous year. As we have seen, the two year trial by Haskell and King (**King et al 1995**) set out to substantiate their assumption that middle aged American men and women would adhere far better to 'moderate intensity lifestyle activities' than to vigorous intensity performed in a group in a gym, or alone, incorporated into their own lifestyles at home. Yet, the best adherence was maintained by the 'vigorous lifestyle' group, while the 'moderate intensity lifestyle' group performed almost as badly as the vigorous gym based group. Moreover, Haskell and King directly observed that the reason for the 'moderates' relative adherence failure could be explained in their difficulty in adhering to a program that required 5 x 30 minutes lifestyle activities a week – the very regime that the US Surgeon General's Report was now proposing as the primary and fundamental plank of its public health recommendations.

Further, the Report's authors and editors cannot claim not to have seen, and indeed to have examined King et al 1995. Not only was King herself a 'contributing author' to the Report, but the findings of her paper with Haskell were mentioned in some detail in the final chapter of the Report itself, where the issues of behavioural adherence were directly addressed. (**USSG 1996 p 226**)

The extent of the incompleteness of, and conflict within, the evidence – was simply downplayed or ignored as the introduction to the Report continued with apparent upbeat self-confidence:

“This report grew out of an emerging consensus among epidemiologists, experts in exercise science, and health professionals that physical activity need not be of vigorous intensity for it to improve health. Moreover, health benefits appear to be proportional to amount [sic] of activity; thus, every increase in activity adds some benefit.” (**op cit p 3**)

Did this 'emerging consensus' literally mean any increase in activity, no matter how low its intensity, short its duration, and small the total volume (kcal) of energy expenditure? Once again, no evidence or citation was given to support the highly contestable assertion that 'amount' measured by total calories alone, regardless of the intensity of the expenditure, yielded this linear improvement in 'health benefits'.

The Report did, however, at least avoid asserting the declaration of a moderate 'physical activity – health paradigm' originally drafted by Blair and Pate and proclaimed by the US Centers for Disease Control (CDC) and American College of Sports Medicine in their 1995 consensus report (**Pate et al 1995 p 405**).

“Emphasizing the amount rather than the intensity of physical activity offers more options for people to select from in incorporating physical activity into their daily lives. Thus, a moderate amount of activity can be obtained in a 30 minute brisk walk, 30 minutes of lawn mowing or raking leaves, a 15 minute run, or 45 minutes of playing volleyball, and these can be varied from day to day.” (**USSG 1996 p 3**)

This somewhat more balanced tone more closely mirrored the more measured words of the National Institutes of Health (NIH) Consensus Report 1996, where Blair and Pate played prominent roles, but where they were prevented by NIH rules (that excluded known 'strenuous advocates') from serving on the consensus panel which actually drafted the report. (**NHLBI bundle 05-30-95**)

Nevertheless, the clear and explicit emphasis remained upon moderate amounts of moderate intensity activity based on the unproven assertion of 'volume theory' – that intensity and duration were interchangeable – that all kcals of energy expenditure were equal in their beneficial impact on health. (**Winett RA 1995**)

9.2.1 Basic Physiologic Evidence is discounted or omitted

This 'volume theory' was not only in direct conflict with then contemporary exercise physiology science (**McArdle et al 1996, Westcot W 1995**). It was also contradicted within the Report itself. Located rather more obscurely in the un-contentious chapter on physiologic responses (Chapter 3: Physiologic Responses and Long-Term Adaptations to Exercise) was this statement:

Low rates of work, such as walking at 4 kilometres per hour (2.5 miles per hour) place relatively small demands on the cardiovascular and respiratory systems...With few exceptions, the cardiovascular response to exercise is directly proportional to the skeletal muscle oxygen demands for any given rate of work, and oxygen uptake (VO_2) increases linearly with increasing rates of work.” (**USSG 1996 p 62**)

Yet this clearly conflicted with the 'moderate-volume' theory -- at the very centre of the US Surgeon General's Report – and was not chosen to be highlighted in the 'bullet points' of that chapter conclusions, and thus it also did not appear in the prominent,

summarising 1st Introductory chapter of the Report (Chapter 1) where these ‘bullet points’ from all chapters of the Report were gathered together and repeated.

Instead, the introductory chapter emphasised a belief in an ‘emerging consensus’ about the benefits of moderate intensity activity, especially (but not exclusively) for the sedentary who lacked the stamina and will power to be more vigorous:

“As understanding of the benefits of less vigorous activity grew, recommendations followed suit. During the past few years, the ACSM, the CDC, the AHA, the PCPFS [President’s Council on Physical Fitness and Sport] and the NIH have all recommended regular, moderate-intensity activity as an option for those who get little or no exercise.” (op cit p 5)

These prescriptions were not targeted exclusively at the sedentary. Moderate intensity activity was represented as the general headline public health recommendation first by the **AHA (1992)** and then by the **CDC/ACSM (1995)** and then by the **NIH (1996)** (see Chapter 8). Further, what this collegiate statement concealed, or at least obscured, was that this ‘emerging consensus’ of opinion was largely the consensus of just a few investigators led by Steven Blair, Russell Pate, Carl Caspersen and to a lesser extent William Haskell and Ralph Paffenbarger. The PCPFS was, and remains, largely a ceremonial body with little independent clout. All the other agencies – the ACSM, the CDC, the AHA and the NIH had all been powerfully influenced (see Chapter 10) by the representation, evidence and opinions of Steven Blair and Russell Pate, leaders of the ‘moderate persuasion’, who also believed, with little if any evidence, that the American public, while keen and well intentioned, was nevertheless particularly poor at adhering to and benefiting from vigorous activities, as the Report continued: “Moreover, although many people have enthusiastically embarked on vigorous exercise programs at one time or another, most do not sustain their participation.” (**USSG 1996 p 5**)

9.3 Chapter 2 of the Report: Historical Background and Evolution of Physical Activity Guidelines

The Report strove, in many respects to provide a balanced account of the impact of physical activity upon health and disease prevention. Yet, even in the least contentious chapters (Chapters 2 and 3), which chronicled the historical evolution of physical activity guidelines and the physiologic response to exercise, the text evidently (over) emphasised the health benefits and ease of adherence of moderate intensity activity. But the language was often more sober and balanced and is summarised briefly, here:

“Numerous expert panels, committees and conferences have been convened over the years to evaluate the evidence relating physical activity and health....Specific exercise recommendations have emphasized only vigorous activity for cardiorespiratory fitness until recently, when the benefits of moderate intensity physical activity have been recognized and promoted as well.” **(op cit p 37)**

9.3.1 Moderate Intensity Guideline Becomes US Government Policy

In evident reference to the recent consensus conferences **(CDC/ACSM Pate et al 1995 and NIH 1996)** the Report said:

“The most recent recommendations advise people of all ages to include a minimum of 30 minutes of physical activity of moderate intensity (such as brisk walking) on most, if not all, days of the week. It is also acknowledged that for most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or of longer duration.” **(USSG 1996 p 37)**

Thus, the new moderate intensity hypothesis had now emerged as the official policy of the US Surgeon General and therefore as the primary physical activity public health message of the US Government. Recommendations to exercise vigorously had been not only de-emphasised, but had been all but discarded – except for the energetic few who actually enjoyed more strenuous activity. The same ‘greater health benefits’ (gained from exceeding the 5 or more weekly 30 minute brisk walk regime) could equally be achieved by doing just more of the same (‘longer duration’). This ‘emerging scientific consensus’ – this new ‘health paradigm’ -- had been officially endorsed by the American authorities and the message would rapidly spread to Britain and the rest of the world. Intensity and duration were interchangeable in public health terms. Vigorous activity was effectively deemed irrelevant. Or was it?

9.4 **Chapter 3 of the Report: Physiologic Responses to Exercise**

9.4.1 The ‘Rate’ of Activity Does Matter

The key notion that longer duration of moderate intensity activity could deliver the same health benefits as shorter bouts of more intense exercise was contradicted when the Report turned to the important scientific issue of how, precisely, does the human body react physiologically to various ‘doses’ of physical activity. We have also seen how the politicians and policy makers quoted in the preamble to the report used various imprecise and conflicting modifiers (intensity, amount and level) while asserting the

benefits of ‘moderate’ activity – itself a poorly defined term. As we have seen above, the authors of Chapter 3 introduced a fourth, new and rather more precise word – ‘rate’ - more accurately to describe the effect of an activity’s intensity on the body’s physiologic response: The result was that ‘rate’ appeared to be a precise measure of intensity (taken from maximal oxygen uptake $\text{VO}_2 \text{ max}$) – and indeed, different ‘rates’ of activity did elicit different physiologic responses:

“When challenged with any physical task, the human body responds through a series of integrated changes in function that involve most, if not all, of its physiologic systems.” (**op cit p 61**). Those listed were musculoskeletal, cardiovascular, respiratory, endocrine and immune systems. Further: “The magnitude of these changes depends largely on the intensity and duration of the training sessions, the force or load used in training, and the body’s initial level of fitness.” (**op cit p 61**).

Thus, intensity and duration were described as quite distinct phenomena. The authors did not say: *Intensity or duration*.

9.4.2 Effect of Relative Fitness

It was explicitly recognised by the Report that any given ‘force or load used in training’ might have elicited quite different physiologic responses from a sedentary individual than from a fit one. Hence Morris’ hypothesis (**see Morris et al 1973, 1980, 1990, Morris JN 1992**) might well have proved accurate for his relatively fit British civil servants, who received significant heart attack risk reduction from vigorous activity (but very little or none from more moderately intense activities). Whereas more sedentary American populations might very much display significant disease or mortality risk reduction from less vigorous activities (**Paffenbarger et al 1993**), or from only modestly better degrees of fitness compared to those who were even more unfit. (**Blair et al 1989**) Here then might be at least some explanation for the conflicting results of Morris, Blair and Paffenbarger over the key issue of the medical and public health importance of exercise intensity.

It is important to note that the Report asserted that an increased ‘rate’ or intensity of activity improves not just narrow cardiorespiratory fitness – but improves the wider ‘cardiovascular response’ as well. (**USSG 1996 p 62**) Supporters of the moderate hypothesis recognised, in most cases, that more vigorous activity was better at improving cardiorespiratory fitness, but they often attempted to argue that moderate activities were as good, or even better, at improving cardiovascular risk factors, not least with levels of HDL cholesterol and blood pressure.

9.4.3 Immune Responses to Exercise

By 1996 it had been fairly well established that activities that combined both vigorous intensity and extreme duration (for example, and most commonly, training for and running a marathon) were actually damaging to the human immune system. The authors of Chapter 3 duly noted this adverse response to 'overtraining'. **(op cit p 67)** However, by contrast they observed:

“Moderate exercise has been shown to bolster the function of certain components of the human immune system – such as natural killer cells, circulating T and B lymphocytes, and cells of the monocyte-macrophage system – thereby possibly decreasing the incidence of some infections.”
(op cit p 67)

Can it have been a mere oversight, however, that the authors of Chapter 3 failed to define whether by “moderate exercise” they meant exercise of moderate intensity, or moderate durations of more vigorous activity? Once again imprecise wording, at the very least, left room for ambiguity, which was exploited rather than made explicit and clarified.

9.4.4 Hormonal Response

Broadly, the Report concluded that physical activity beneficially alters the human hormonal system. However, its evidence base appears to have been taken and adapted from a single table **(Wilmore JH and Costill DL 1994)** which itself had apparently been compiled from short-term exercise physiology studies which would have been conducted at relatively high intensity among healthy adults. Thus, little if anything can be drawn from the fact that almost all of the beneficial hormonal responses were reported after 'intense exercise' or 'training'. In one study, however, intensity comparisons were made. The hormone ACTH-cortisol, which beneficially increases gluconeogenesis in liver and increases mobilisation of fatty acids reacted thus: “Greater increase with intense exercise; increases less after training with submaximal exercise.” **(op cit p 68)**

However this differential intensity outcome was not examined in the text of the Report. In the summary of research needs at the end of Chapter 3 the Report made no recommendation to discover the relative importance of intensity, duration and frequency of physical activity in improving pre-determined physiologic responses. Once again the loose language ('amount') of their request was imprecise and ambiguous: “Determine the minimal and optimal amount of exercise for disease prevention” **(op cit**

p 77) – apparently another implicit acceptance of the contentious ‘volume’ hypothesis as robust scientific fact.

9.5 Chapter 4 of the Report: The Effects of Physical Activity on Health and

Disease

The Surgeon General's Report described itself as a broad examination of the effect of, not just structured exercise, but all physical activity upon human health. However, its predominant focus was upon the impact of moderate intensity aerobic activity (to the relative exclusion of vigorous intensity aerobic activity and of resistance (weights or muscular strength) training. Moreover, its predominant health focus was on cardiovascular disease (CVD), with other health outcomes/diseases evidently given much less coverage.

Why were these foci chosen? We have examined at length the so-called ‘emerging consensus’ that powered the argument for the under-examined or under-valued benefits of moderate intensity activity. But did the focus on cardiovascular disease (primarily CHD and stroke) arise simply because of the association between it, as the leading cause of death, and physical activity, as a major a risk reducer, was both strongest and longest? Or were other factors also at work?

9.5.1 Focus on Cardiovascular Disease and Cancer

First, it should be recalled that the landmark US Government-funded *Framingham Heart Study*, which began in 1948, first identified physical (in)activity as a major risk factor in cardiovascular disease in 1967 (**Kannel WB 1967**) – nearly two decades before extensive examination of similar (causal) links with other important diseases were being seriously investigated. Second, the importance of physical activity and structured exercise as a recovery tool for rehabilitation of heart disease patients had also been well established. Third, and concomitantly, the medical literature on physical activity and health had been overwhelmingly focused on cardiovascular disease. **(personal communication with KE Powell, Atlanta, Georgia and A Franksn Northampton, Massachusetts May 2007)**. Indeed, this was made explicitly clear in the introduction to Chapter 4: of the Report which said:

“The primary focus is on diseases and conditions for which sufficient data exist to evaluate an association with physical activity, the strength of such relationships, and their potential biologic mechanisms....The majority of population-based research in the area of physical activity and health has focused on some aspect of CVD.” (**USSG 1996 p 85 & 87**)

Within Chapter 4 of the Report, a total of 56 pages were given to analysis of the impact of physical activity to specific diseases and health outcomes. While allowing for some page overlap, the number of pages given to each (and its order of presentation), is listed below:

<u>Health Outcome/Disease</u>	<u>Page Coverage</u>
Overall Mortality (includes CVD)	1
Cardiovascular Diseases	26
Cancers	12
Type 2 Diabetes (NIDDM)	4
Osteoarthritis	2
Osteoporosis	3
Obesity	2
Mental Health	6

It is beyond the scope of this dissertation fully to examine this balance of health outcomes coverage, or indeed to look in depth at the evidence presented for the protective benefits of physical activity other than for cardiovascular disease. But several observations need to be made.

First, the extent of coverage given to each outcome may, to some extent, have also reflected opinion within the CDC about public perception of the prevalence and importance of each disease, and not merely the known benefits (or size of) the existing physical activity literature associated with it. It has been argued, for example, that the American public's fear of cancer was and is, for complex reasons, substantially greater than that of the British public's and that therefore Americans have expected their public health and environmental agencies to take greater care to investigate ways to prevent it. **(Gillespie et al 1982 pp 322, 325-27)**

Nevertheless, with the single exception of colon cancer, the scientific literature of the period did not suggest a clear beneficial association with physical activity. At best, for other cancers the literature showed mixed results and were thus inconclusive in suggesting that physical activity (of any intensity or duration) was protective against any other forms of the disease. Yet, in the final Report 12 pages were devoted to

analysis of cancer which yielded very little, even after it had, apparently, been stripped of what might be described politely as un-rigorous over-enthusiasm for the protective benefits of physical activity. According to Adele Franks, who asserted that she was brought in at a late stage to rescue the Report:

“I believe that we drastically changed and shortened and eliminated some whole chapters with other [than CVD] health outcomes that just weren’t supported [by the scientific evidence]. The cancer chapter was a disaster. We had to peel that one way back. I believe obesity was horrible and we had to peel that one way back too.” **(personal communication with A Franks, Northampton, Massachusetts May 2007).**

Franks’ observation suggests that the ‘public health enthusiasm’ of some physical activity investigators invited to work on the Report may have led them to attempt to draw positive conclusions about the effective benefits of physical activity that were simply unsupported, or insufficiently supported by the available scientific evidence in the literature.

The exceptional, and arguably anomalous prominence of the American Heart Association (AHA) in formulating US public health policy on physical activity in the 1990s will be examined in some depth in Chapter 10, and so shall only be summarised here. Between 1990 and 1996 the AHA launched a flurry of position papers, workshops, conferences – and indeed a ‘strategic plan’ (with it at the helm) aimed at improving the public health profile of physical activity, and particularly moderate intensity activity. It was during this period that Steven Blair and close colleagues such as Russell Pate and Carl Caspersen gained influence and important roles within the AHA. The association’s lobbying influence, and particularly its decision to spearhead a strategic plan that would allow it to act as an umbrella for other charities and pressure groups evidently impressed senior officials at CDC. Michael Pratt recalled:

“Yes, the links and literature on CVD were much greater and longer (than for other diseases). The AHA had just produced, in 1994, its strategic plan for physical activity, ranking it up with smoking, blood pressure and cholesterol. The focus was very much on CVD, by comparison, other diseases were pretty much added on.” **(personal communication with M Pratt, January 2007)**

Pratt also confirmed that the only person outside of government or an academic institution who played a senior role in the Report’s construction was Terry Bazzarre,

head of physical activity and nutrition at the American Heart Association, who was himself a close friend of Steven Blair.

So it would appear that the explicit and entirely understandable emphasis on cardiovascular disease was enhanced by the alliance between Blair's group of investigators, the AHA and senior people at the CDC including Michael Pratt and Ken Powell. Exactly who and what might then have benefited from this liaison? First the American Heart Association, itself.

9.5.2 The American Heart Association (AHA)

Chapter 10 will draw further upon the work of Karin Garrety to examine how the AHA grew suddenly and exponentially in the 1950s into a powerful fund raiser for, and exponent of, heart disease research. It was able therefore to establish close links with the *Framingham Heart Study* and thus its funding body, the National Heart, Lung and Blood Institute at the US Government's National Institutes of Health (NIH). Indeed, the bibliography from the *Framingham Heart Study* shows that a high proportion of its studies were, and continue to be published in *Circulation*, the primary journal of the AHA. Yet, even though the Study had declared physical inactivity to be a major heart disease risk factor in 1967, the AHA had not until the 1990s established important links with the physical activity unit at the CDC, even though this had been set up by Powell in 1983. **(personal communication with KE Powell, Atlanta, Georgia May 2007)**

But by the early 1990s the AHA began quickly (as was explored in Chapter 8) to become heavily involved in the physical activity and public health debate and was thus in a strong position to lead the external pressure to conceive a Surgeon General's Report. Having been persuaded by Blair and his group of the benefits (health and adherence) of moderate intensity activity as a general health prescription, the AHA would have been eager to get their man, Bazzarre, on to the planning board of the Report to ensure that the 'moderate message' was emphatically adopted and promulgated: Terry Bazzarre recalled:

"I had the opportunity to review the full report, and to provide comments about the science, [and] comments about the extent to which there were any contributions from the AHA [that could be made] to that science." He added: "As the publication date [of the Report approached] we hoped we [at the AHA] could release [the findings] in advance. We also realized we

needed to find partners who shared our values. We were building and strengthening relationships with the CDC, with the ACSM [American College of Sports Medicine] and others. So I was there when the National Coalition for Promoting Physical Activity [conceived in the AHA Strategic Plan 1994] began to make sense.” **(personal communication with T Bazzarre, Princeton, New Jersey May 2007)**

9.5.3 The Centers for Disease Control (CDC)

The CDC took little interest in the disease prevention effects of physical activity until Ken Powell succeeded in setting up the Behavioral Epidemiology and Evaluation Branch (BEEB) in 1983 – the primary responsibility of which was “the epidemiologic study of physical activity”. **(Powell and Paffenbarger 1985 p 118)**

Powell had trained as a physician but almost immediately preferred public health to clinical practice and joined the CDC in the 1960s working in the conventional prevention area of the time, infectious diseases. A keen runner, Powell began to examine the work of Paffenbarger and other early investigators and then to question why physical activity was not seen, on a par with smoking cessation, nutrition and alcohol moderation as an important environmental factor in disease prevention. Powell said:

“Resistance at first within the CDC was actually quite considerable to physical activity – not within our immediate hierarchy, but certainly within the divisional and central level.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

Powell advertised for an exercise physiologist with an interest in public health and hired Carl Caspersen who, in turn, introduced him to Steve Blair. Together with Paffenbarger they conceived the landmark workshop in 1984 on Epidemiologic and Public Health Aspects of Physical Activity which drew together the few experts in the nascent field from all over of the United States. With hindsight a direct line can be seen between that first workshop and the CDC/ACSM conference **(Pate et al 1995)**, the NIH consensus conference **(NIH 1996)** and the Surgeon General’s Report itself.

Powell believes that the early public health focus on cardiovascular disease was both necessary and appropriate:

“I don’t think the emphasis on CVD was poorly placed....we only had four people in this unit (BEEB) and so we were not going to mount huge investigations into umpteen outcomes especially when, as far as we could

tell, the only outcome with much supportive evidence was CVD. When you put that together with the fact that CVD is the single largest cause of death in the United States -- that made a lot of sense to us that we should focus on it.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

Powell said he recognised at the outset that the support of some broadminded cardiologists, especially those with influence within the AHA, would be crucial in boosting physical activity’s reputation as a front rank public health prescription:

“No one else was thinking along those lines except some cardiologists. Heart disease was the big killer, and the evidence, such as it was, seemed to be the best, so that seemed to be the appropriate arena to go in....at that time, in 1983, there was in the scientific community not [even] a solid consensus that physical activity reduced the incidence of coronary artery disease.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

9.5.4 The Prominent Role of Steven Blair and His Group

The emerging bridge between the CDC and the AHA was Steven Blair and other close colleagues including Carl Caspersen and Russell Pate. In the language of Garrety, they ‘enrolled and translated’ their way into powerful positions within the AHA. **(Garrety K 1997 p 727)**, just as Ancel Keys had done two decades earlier in a successful effort to turn his unproven cholesterol hypothesis into ‘warranted’ medical orthodoxy. Now Blair and his group would seek to win the same stamp of ‘warranted authority’ from the AHA for their moderate-intensity hypothesis and -- go even further. Attempts by Keys and his colleagues to get a US Surgeon General’s report on cholesterol foundered. According to Bazzarre, drafts of a cholesterol report were started, but internal disagreements among participants and factions led to it being shelved. **(personal communication with T Bazzarre, Princeton, New Jersey May 2007)**

The US Surgeon General’s 1996 Report on Physical Activity and Health would not only be published – but it would very much endorse and promulgate the moderate-intensity public health prescription championed by Blair and his colleagues. This outcome was beneficial to Blair and his group in several ways. There can be no question but that the primary motive of these investigators appears to have been to improve the public health. **(Blair and Paffenbarger 1992, Powell and Blair 1994, Pate et al 1995)**. They also undoubtedly believed, with considerable justification, that the dangers of sedentary living, and the benefits of regular physical activity as a disease prevention prescription

had been substantially undervalued and thus ‘undersold’ to the American public by the more established elements of the public health community. They hoped that the power and influence of a full US Surgeon General’s Report would go far in addressing that imbalance. In parallel, of course, this redress could only enhance the reputations of their disciplines, their institutions and themselves as individual academics and public health advocates. Finally, they also believed (albeit with incomplete and conflicting evidence) that the new moderate-intensity recommendation would provide a greater and broader public health improvement (than the existing vigorous guidelines) since its clinical benefits were greater than previously realised, and it would, in any event, enjoy greater long-term adherence (particularly among the poor and sedentary) because it was physically easier to do and sustain. **(personal communication with SN Blair, London 2004, 2006, 2007, KE Powell 2007, A Franks 2007, M Pratt 2007 and T Bazzarre 2007)**

While it is beyond the scope of this dissertation to look closely at all of the health outcomes dealt with in the Report (listed above) the treatment of activity intensity and duration will now be examined in depth concerning cardiovascular disease, and briefly in relation to all cause mortality, cancer, and type 2 diabetes (DM2 or NIDDM) and obesity. Somewhat greater attention will be given to obesity in order to explore the apparent anomaly of why well established knowledge about energy balance (between intake and activity expenditure) was given relatively short attention -- at a time when evidence of the rising incidence and prevalence of unhealthy weight gain was emerging.

9.6 Chapter 4 of the Report: Intensity v Volume in Relation to Health Protection

9.6.1 Overall (All-Cause) Mortality and Cardiovascular Disease

Before the Report turned in Chapter 4 to discuss the evidence on physical activity and cardiovascular disease, it turned briefly to the less frequently examined study of all-cause or overall mortality, which was, and is still heavily influenced by the high incidence of cardiovascular disease mortality itself. The Report tended, therefore, to blur the distinction because studies which looked at all-cause mortality (notably Blair and Paffenbarger) also examined its prime component, cardiovascular mortality, in depth as well. Its conclusion, while apparently un-contentious, was also unclear and therefore ambiguous: “The data reviewed here suggest that regular physical activity and higher cardiorespiratory fitness decrease overall mortality rates in a dose-response fashion.” **(USSG 1996 p 87)**

What exact 'dose' of physical activity did the authors have in mind? By 'regular' did they mean regular 'frequency' as the dose, without regard to intensity or duration? Was a regular stroll equal to a regular jog? Or did 'regular physical activity' only impact on mortality if, in a linear fashion, it increased cardiorespiratory fitness? The text failed to provide an answer to those questions.

The core Chapter 4 of the Report, in large measure, avoided discussing the key issue of intensity of activity, except perhaps, when it could, on rare occasions be used to bolster the 'moderate-intensity' hypothesis where, unusually, the studies (see particularly on hypertension below) appeared to show better results from moderate intensity activity than from vigorous. The Report chose, for example, to highlight one seldom cited longitudinal follow-up study on all-cause mortality, the subjects of which were exclusively male Seventh Day Adventists. **(Lindsted et al 1991)** This study reportedly "found an inverse association among the moderately active group but less of an effect in the vigorously active group." **(USSG 1996 p 87)**

9.6.1.1 Blair et al 1989

Surprisingly, Blair's seminal 1989 results on all-cause mortality **(Blair et al 1989)** were mentioned, but only to highlight the fact that studies examining fitness with some precision (as his did) tended to show stronger inverse associations with mortality (of any kind) than did studies which tried to measure the more amorphous and imprecise concept of physical activity, especially when captured by less-than-precise self-reported questionnaires. Curiously, however, there was no reference to the stunning mortality reductions he reported among the subjects in the second least fit quintile – compared to the most sedentary – even though his paper described that fitness level as achievable with a moderate intensity 'brisk walk' of as little as 30 minutes each day. **(Blair et al 1989 p 2400)**

This steep concave curvilinear outcome was again ignored in the Report when **Blair et al 1989** was cited one page later and included under discussion of "five large cohort studies relating cardiorespiratory fitness to risk of CVD mortality". Its distinctive concave curvilinear trend simply disappeared: "Each of these studies demonstrated an inverse dose-response relationship between level of cardiorespiratory fitness and CVD mortality." **(USSG 1996 p 87)** When the study was listed in Table 4-1 of the Report, its cardiovascular findings were bafflingly described as "inverse association....significant linear dose response" **(op cit p 89)**

One might tentatively surmise that Blair's finding of a steep concave curvilinear trend of such 'public health importance' was not reflected in the US Surgeon General's Report because this remarkable curve was not replicated in the 1996 extension and follow up of the Aerobic Center Longitudinal Survey (ACLS) cohort (**Blair et al 1996**) -- as was discussed in Chapter 8 . Further, Blair was unable in 2007 to recall whether he drew these later and then unpublished results, which were inverse, but linear (not curvilinear), to the attention of the authors and editors of Chapter 4 before they finished compiling the Report, even though he was, himself, the senior scientific editor of the Report. **(personal communication with SN Blair, London, October 2007)**

9.6.1.2 'Levels': Further Conflation of Intensity and Duration

Direct discussion of the importance of the intensity of energy expenditure was also deflected by the introduction of the measurement term – 'levels':

"The demonstrated dose-response relationship indicates that the benefits derived from physical activity occurs at moderate levels of physical activity or cardiorespiratory fitness and increases with increasing levels of physical activity or higher levels of fitness." (**USSG 1996 p 87**) **(emphasis added)**

Fitness is a singular and relatively precise measure of cardiorespiratory output (usually % of VO_2 max - maximal oxygen uptake) and thus can be ranked in 'levels' or degrees. But a 'dose' of physical activity can only be accurately described and defined by measuring both its intensity and duration, before considering the frequency with which that precise dose of activity is conducted. Only when these three parameters are independently measured, might a 'level' of physical activity be accurately and explicitly defined.

The term 'level' is also unhelpful in that it was seldom used in the epidemiologic literature which the Report's authors and this dissertation have surveyed. Indeed, the two defining consensus conferences that immediately preceded the Report (**CDC/ACSM Pate et al 1995 and NIH 1996**) both specifically recommended 'moderate-intensity' activity as their precise public health guideline with duration (30 minutes) and frequency (5+/wk) also specifically defined.

Nor would the use of the term 'level' appear to have been arbitrary, or accidental. For when summarising and concluding the section on cardiovascular diseases the Report again observed:

"The epidemiologic literature supports an inverse association and a dose-response gradient between physical activity level or cardiorespiratory

fitness and both CVD in general and CHD (coronary heart disease) in particular.” **(USSG 1996 op cit p 112)**

By using the term ‘physical activity level’, the Report thus conflated the three more precise measures of activity (intensity, duration and frequency). This allowed the anomalous interpretation that the ‘inverse dose-response’ in disease prevention was, for example, identical from a lower-intensity, longer-duration activity done 5 times a week - as compared with a higher-intensity, shorter-duration activity done 3 times a week. Thus 30 minutes of brisk walking 5 times a week (the Report’s preferred new public health guideline prescription) would provide exactly the same physiologic response in providing disease protection as 20 minutes of jogging 3 times a week. But as we have seen, this concept had been discredited some pages earlier in Chapter 3 of the Report. Lower ‘rates’ of work, as defined by speed or intensity of walking, produce less cardiovascular response. **(op cit p 62)**

9.6.1.3 Lee et al 1995

As discussed earlier in this chapter, the Report anomalously did not even cite, and much less discuss the most recent study **(Lee et al 1995)** co-authored by Ralph Paffenbarger. This omission appears all the more curious and surprising because Paffenbarger and Lee, in the long running Harvard Alumni Study, chose in this most recent investigation precisely to focus upon and examine the importance of the intensity of energy expenditure in reducing all-cause mortality. As was seen in Chapter 8, Figures 8.5, 8.6, and 8.7) their conclusion was clear: Vigorous activity significantly reduced mortality, whereas non-vigorous activity did not. **(Lee et al 1995 p 1181)** If Paffenbarger and Lee suspected that their Harvard cohort were fitter than a typical American population (and thus measurably responsive to low-to-moderate intensity activities) they did not report on this consideration. Further, it should be noted that the ‘vigorous only’ finding would not prove a rogue result. The finding and broadly replicated in an update of the Harvard Alumni Study five years later. **(Lee and Paffenbarger 2000 and Sesso et al 2000)**

The question therefore remains: How and why was this highly pertinent piece of research, published in a supremely reputable US medical journal, and investigated by the field’s most eminent scientists, at best overlooked, and at worst, intentionally ignored by those trusted with writing the US Government’s definitive public health report and recommendations on physical activity? The answer appears to lie in the fact that latest findings from Paffenbarger’s team seriously undermined the ‘moderate hypothesis’ which, in turn, underpinned the radical decision to downgrade the

importance of vigorous intensity activity – and to replace it with a moderate-intensity and total volume activity prescription as the new primary public health recommendation from the United States government. In their desire to promote a single and simple public health message, which they hoped would bring ‘substantial health benefits’, especially to the majority of sedentary Americans, they apparently chose to ignore important scientific evidence which undermined an unproven hypothesis that was presented as a fully ‘warranted’ scientific fact.

9.6.2 Cardiovascular Disease (Hypertension) – Intensity (Moderate) Does Matter

Having largely ignored the intensity debate – or simplified it with use of terms like ‘levels’ and ‘amount’, the Report became unusually interested in the comparative intensity of energy expenditure when it turned to examine the scientific literature on hypertension which was reviewed in the cardiovascular diseases section of Chapter 4. Did this sudden shift of focus and interest possibly occur because it had found some recent evidence to suggest, that for reasons unexplained, moderate intensity activity appeared in some cases to improve (lower) blood pressure (systolic and diastolic) more significantly than higher intensity activity? It would appear so, and the hypertension section was concluded thus:

“Three (intervention) trials have specifically examined the effect of different intensities of exercise on blood pressure.” **(Hagberg et al 1989, Matsusaki et al 1992, Marceau et al 1993). (USSG 1996 p 110)** After briefly reviewing the findings, the Report concluded, albeit tentatively, that:

“These trials provide some evidence that moderate intensity activity may achieve a similar, or an even greater blood-pressure lowering effect than vigorous-intensity activity.” They remained cautious, of course, but they were able to suggest: “Because few studies have directly addressed the intensity question, however, the research base is not strong enough to draw a firm conclusion about the role of activity intensity in lower blood pressure.” **(USSG 1996 p 110)**

The Report nonetheless held out the encouraging prospect that further research might quite possibly add further weight to the ‘moderate hypothesis’. However, the available and much broader research base on hypertension which they also reviewed provided a very different analysis and interpretation. The Report cited two recent meta-analyses which had together reviewed 22 controlled intervention trials, most of which were conducted at vigorous intensity and overall showed significant reductions in systolic

and diastolic blood pressure in both hypertensive and normal subjects. Moreover, the authors of one of the meta-analyses concluded that the key determinant was not intensity but frequency of activity: “All activities, including weight training, lowered blood pressure and daily activity produced greater blood pressure reduction than when performed [only] three times per week.” (**Arroll and Beaglehole 1992 p 439**)

Second, the Surgeon General’s Report included a table (**USSG 1996 Table 4-4 pp 108-09**) showing the results of 6 population-based cohort studies which had examined the association of physical activity and hypertension. Only 2 directly compared moderate and vigorous intensity activities and both of these studies showed better results from vigorous than moderate intensity expenditure. Paffenbarger was reported to have found a 30% reduced risk of developing hypertension among male subjects who played vigorous sports compared to those who did not. (**Paffenbarger et al 1991**) Similarly, Folsom and colleagues found among 41,000 Iowa women that those who reported ‘high levels’ of physical activity had a 30% reduced risk of developing hypertension compared to those reporting ‘low levels’, whereas those who reported ‘moderate levels’ had only a 10% reduced risk. Once again, the term ‘levels’ conflates, but it appears safe, especially in such a large cohort, to assume that those who reported ‘high levels’ took part in more higher intensity activity than those who reported less. (**Folsom et al 1990**) This information, while supplied in Table 4.4, was not discussed in the text – not even when the Report was directly addressing the issue of intensity.

Finally, of those three trials cited above that specifically examined intensity, only two favoured moderate intensity activity (and only in one measure of blood pressure), while the third showed similar results for moderate and vigorous intensity. Moreover, all three studies were short term and had very few subjects (n=33, n=26, n=11, as above respectively) all of whom were already diagnosed as being hypertensives. One must question what important public health assumptions could be drawn from such small, and symptomatic samples, and why the Report drew such attention to them.

In summary, then, the Report chose anomalously to focus on intensity of activity when, in 3 small intervention studies, some unusual, but hardly conclusive evidence emerged that moderate intensity was superior in lowering hypertension while a much greater quantity of significant evidence to the contrary was de-emphasised or discounted.

9.6.3 Cardiovascular Disease (HDL Cholesterol)

A similar example of apparent selective interpretation occurred in the Report's review of the HDL (high density lipoprotein cholesterol) literature on activity intensity. It reported that literature reviews showed that 'about half' of some 60 studies found increased HDL after 'exercise training', -- a term strongly suggesting at intensities normally considered to be more vigorous than moderate. Yet, it went on specifically to highlight one single study, Duncan et al's 1991 randomised controlled trial (see Chapter 7): "Moderate-intensity exercise was seen to increase HDL as much as more vigorous exercise in one randomized controlled trial of women." (**USSG 1996 p 111**)

But other, well designed studies which clearly showed the superiority of higher intensity and/or higher fitness (**for example: Folsom et al 1985, Blair et al 1983, Lakka et al 1992**) were not given similar highlight, or not mentioned at all.

9.6.4 Colon Cancer – Intensity Obscured Again

In 1996 cancers accounted for about 25% of all deaths in the United States. This high incidence, coupled with the public's perceived and particular fear of the diseases, may help explain why more than 12 pages of the Report were given to the assessment of the preventative, or protective impact of physical activity on 7 categories of cancer (colon, rectal, breast, other hormone-dependent cancers in women, prostate, testicular, and other site-specific cancers). However, the Report found a strong (preventative/protective) association only between physical activity and colon cancer, and only this association will be discussed here.

The conclusion on colon cancer in Chapter 4 stated, without reference to, or qualification by specific intensity, duration or frequency, simply and broadly that:

"The relative consistency of findings in epidemiologic studies indicates that physical activity is associated with a reduced risk of colon cancer, and biologically plausible mechanisms underlying this associated have been described." (**USSG 1996 p 124**)

The impression given was that all physical activity is protective. Yet simple analysis of data supplied in the Report itself, and a closer reading of data which the Report did not address, showed again that the issue of intensity was, anomalously overlooked, ignored, dismissed or not adequately considered.

First, In discussion of likely biologic mechanisms for protecting against colon cancer (only paragraphs before the general, unqualified conclusion above) the Report specifically cited sources which concluded that intensity of the activity was apparently

an important factor in colon cancer protection because of its favourable impact on faster intestinal motility:

“Strenuous physical activity increases prostaglandin F2 alpha, which strongly increases intestinal motility, and may suppress prostaglandin E2, which reduces intestinal motility and, released in greater quantities by colon tumor cells than normal, accelerates the rate of colon cell proliferation.” **(op cit p 124)**

Second, the Report again included important outcome data from relevant studies in tabular form **(op cit table 4-5 pp 114-15)**, yet anomalously failed to comment upon it in the text. For example, among the 11 studies listed, at least three specifically tested for, and found, a strong protective effect of ‘vigorous’ or ‘strenuous’ intensity activity on colon cancer **(Giovannucci et al 1995, Longnecker et al 1995 and Slattery et al 1988)**. No attempt was made in the text of the Report to consider whether higher intensity activities were essential, or at least conferred greater protective effect, than those of moderate intensity.

Of even more concern than omission, perhaps, was the apparent distortion of the data that was supplied in table 4-5 from both the Giovannucci and Slattery studies – which implied that intensity was not an important element of the ‘activity doses’ that they tested. For example, the large questionnaire study by Giovannucci and colleagues of 47,000+ male health professionals was described in the table as using a “weekly recreational physical activity index based on 8 categories of moderate and vigorous activities.” **(USSG 1996 p 116 table 4-5)** This may have suggested an even mix of intensities and/or a failure of the study’s authors to be precise in measuring exercise dose. Closer inspection of the study, which was supervised by Walter Willett at Harvard University’s School of Public Health, reveals very close attention to the activities recorded:

“Participants reported the average time per week spent doing each of eight moderate and vigorous activities, choosing from among 10 possible responses that ranged from 0 minutes to 11 or more hours per week. The specific activities listed were walking or hiking outdoors (including walking during golf); jogging (slower than 10 minutes/mile); running (10 minutes/mile or faster); bicycling (including that done on a stationary machine); lap swimming; tennis, squash, or racquetball; and callisthenics or rowing. In addition, each respondent reported the number of flights of stairs he climbed daily and his usual walking pace.” **(Giovannucci et al 1995 p 328)**

With the probable exception of much of the walking and some bicycling and stair climbing, all of these activities were characteristically classed as vigorous: ≥ 6 METs (**Ainsworth et al 1993, and 2000**) Furthermore, from the answers to the questionnaires Willett's team then assigned a weekly MET score 'activity level' to each subject, which was, unfortunately aggregated (thus conflating intensity and duration). Nevertheless, a protective effect was seen (referent to sedentary) at fairly low MET scores, suggesting that moderate amounts of moderate intensity activity did have a protective effect. However, increasingly higher scores gave increasing protection in a linear fashion, which were unlikely to have been achieved without considerable vigorous intensity activity given the intensity of most of the list of activities recorded.

"The median activity level of 11.3 MET-hours/week for the cohort was low, approximately equivalent to 1 hour of running, 2 hours of tennis, or 3 hours of walking at a moderate pace. The median level is an underestimation because we assessed only eight common activities, but our results suggest that relatively modest levels of physical activity may substantially reduce the risk for colon cancer. However, up to at least 46.8 MET-hours/week (the 90th percentile), the higher the activity level, the lower the risk for colon cancer." (**Giovannucci et al 1995 p 333**)

9.6.5 Type 2 Diabetes DM2 (NIDDM non-insulin dependent diabetes mellitus)

A failure adequately to discuss and recognise activity intensity occurred again in the smaller section on Type 2 Diabetes. Paffenbarger used his now familiar 'physical activity index' when he looked at DM2 incidence among his Harvard Alumni population (**Helmrich et al 1991**) The US Surgeon General's Report did make one brief and passing reference to the study's finding for the superiority of higher intensity activity: "This study showed a more pronounced benefit from vigorous sports than from stair climbing or walking." (**USSG 1996 p 126**) But it made no further comment. Nor did it draw attention to the fact that all three studies that it chose to include (**table 4-8 op cit p 127**) specifically reported the beneficial effect of 'vigorous sports or activity' on DM2 protection.

In discussion of 'biologic plausibility' the primary mechanism also appears to have been the effect of higher intensity activity: "In general, studies of exercise training have suggested physical activity helps prevent NIDDM by increasing sensitivity to insulin." And: "Insulin sensitivity and rate of glucose disposal are related to cardiorespiratory fitness even in older persons." (**op cit p 128**)

And yet, in the conclusion no mention of the importance of exercise intensity or cardiorespiratory fitness was made. Instead, a broad and imprecise recommendation was made that: “The epidemiologic literature strongly supports a protective effect of physical activity on the likelihood of developing NIDDM in the populations studied.” (**op cit pp 128-29**)

9.6.6 Obesity: Selective Interpretation and Omission of Evidence

Given the considerable and historic physiologic understanding of the benefits of long term balance between energy expenditure and energy intake, it may, at least from an early 21st century perspective, be difficult to comprehend why the *US Surgeon General's Report on Physical Activity and Health 1996* devoted just two pages to unhealthy weight gain and obesity. Indeed, the Report's opening remarks can only be judged as dismissive in assessment of the scientific role of physical activity (energy expenditure) in preventing unhealthy weight gain:

“It is commonly believed that physically active people are less likely to gain weight over the course of their lives and are thus more likely to have a lower prevalence of obesity than inactive people; accordingly, it is also commonly believed that lower levels of physical activity are a cause of obesity. Few data, however, exist to evaluate the truth of these suppositions.” (**USSG 1996 p 133**)

9.6.6.1 Obesity and intensity of Physical Activity

Turning again briefly to the specific issue of intensity of activity, it is surprising how the Report, either with imprecision, or by selective omission, neglected the importance of intensity of energy expenditure when discussing physiologic outcomes. It concluded simply that: “Independent of its effect on body weight and total adiposity, physical activity may favourably affect fat distribution.” (**USSG 1996 p 134**) The Report examined six studies from the United States, Canada and Europe. (**Kaye et al 1990, Slattery et al 1992, Troisi et al 1991, Wing et al 1991 Seidell et al 1991 Tremblay et al 1990**) None specifically found moderate intensity more effective, while three observed to a greater or lesser degree, that higher intensity activity was more effective in improving the waist to hip ratio than less intense activity. (**Slattery et al 1992, Troisi et al 1991, Wing et al 1991**) A European study by Seidell and colleagues (**Seidell et al 1991**) only recorded a significant effect from ‘sports activities’.

The sixth study cited provided even stronger evidence that the Report was highly selective in its mis-interpretation of the very evidence that the Report's authors

reviewed. This study (**Tremblay et al 1990**) was led by Claude Bouchard who would soon become, and remains, the director of the Pennington Biomedical Research Centre at Louisiana State University – arguably the most respected academic centre for obesity research in the United States. Most of the other studies cited above were multi-factorial and had several determinants: physical activity was only one of several aspects investigated of behaviour or the environment (others most commonly included diet and smoking) that might affect body fat distribution. Not only did Bouchard and his team look exclusively at physical activity but they looked specifically at and entitled their study: *Effect of Intensity of Physical Activity on Body Fatness and Fat Distribution*.

Subjects were more than 26,000 men and women who had answered the 1981 Canada Fitness Survey and were subsequently measured by subcutaneous skinfold instruments and for waist and hip circumference. Both sexes were categorised into four subgroups judged by the intensity of the leisure time activities. The authors concluded:

“In general, subjects practicing vigorous activities on a regular basis had lower subcutaneous skinfold thicknesses and waist-to-hip ratios (WHRs) than those not performing these activities.” (**op cit p 153**).

They went even further in rejecting the ‘total volume’ hypothesis of the Report and the ‘moderate modernisers’ led by Blair and his group: Bouchard and colleagues observed:

“These differences remained statistically significant after a covariance analysis was used to remove the effect of total energy expenditure of leisure time activities on subcutaneous fat and fat distribution....This result suggests that high-intensity exercise is associated with a preferential mobilization of abdominal fat.” (**op cit p 153 and 157**)

9.6.6.2 Summary of Obesity Evaluation

The US Surgeon General’s Report on Physical Activity and Health could have been criticised for failing, despite emerging evidence from the CDC, to address rapidly and fully enough the growing incidence and prevalence of obesity in the United States – caused in large part by the sedentary lifestyles of Americans about which the Report’s authors were acutely aware.

In the limited space allocated, the Report failed adequately to distinguish and appreciate the strong protective role that physical activity had been shown to play in preventing unhealthy weight gain from its less convincing role in successfully sustaining long term weight loss among people already obese. It undervalued,

misinterpreted or omitted review of considerable evidence from important observational and intervention studies that physical activity does play an important role in preventing unhealthy weight gain throughout life.

Finally, and most disconcertingly, the Report inexplicably ignored or omitted examination of the importance of intensity of activity – when the evidence (both that which it reviewed and that which it failed to cite) clearly showed, from most studies, that vigorous or intensive activity was superior to moderate intensity activity as a public health tool to protect against unhealthy weight gain, abdominal fat, and morbid obesity.

9.6.7 'Dose'

From its opening pages the US Surgeon General's Report proclaimed the arrival of an 'emerging consensus' of scientific evidence and opinion that allowed it ('warranted scientific authority') to recommend moderate amounts of moderate-intensity activity as the best public health guideline advice for the American people. However, after 145 pages, and having addressed all the major health outcomes, the Report finally focused on the problem of what it described as the 'dose' of physical activity that ought to be given in a public health 'prescription'. This might be construed as odd and late placement of such an important issue, which surely could not ignore the question of intensity within that 'dose'

The Report explicitly recognised that physical activity needed to be described by its various 'dimensions': mode, intensity, duration, and frequency (**USSG 1996 p 147**). However, it found itself with a dilemma of its own making: The Report had committed itself, as we have seen, with little visible evidence, to the notion that it was scientifically and physiological unimportant how two functions were mixed – intensity and duration could be inter-changed. Thus no examination of the importance of varying intensities of activity to effect specific health outcomes was necessary (except on the rare occasion when moderate intensity could be construed as superior). Again the Report repeated the central claim of the 'moderate hypothesis' that the important measure was simply the total volume (kcal of expenditure) or the 'amount' of physical activity:

“Since amount of activity is a function of intensity, frequency and duration, increasing the amount of activity can be accomplished by increasing any, or all, of those dimensions.” (**op cit 147**)

Furthermore, the Report argued that such scientific scrutiny was ‘problematic’ because the epidemiologic studies in the field had not been ‘standardized’ – a euphemism, perhaps for scientific methods, design and interpretation that lacked rigour and precision.

“Using the epidemiologic literature to derive recommendations for how much and what kind of physical activity a person should obtain is problematic, in part because the methods for measuring and classifying physical activity in epidemiologic studies are not standardized.” **(op cit 146)**

The literature, the Report argued, could therefore only be relied upon to show a causal trend between an increasing total volume of activity and increasing health benefits – anything more precise was unfortunately just not possible – unless, of course, moderate intensity activity could be construed to be equal, if not superior to vigorous intensity:

“Such studies are less helpful, however, in assessing the relationship of health benefits to intensity of physical activity (i.e., how hard one must work during the activity itself) because few studies have separately measured or analyzed levels of intensity while taking into account the other dimensions of activity (e.g., frequency, duration, total caloric expenditure). As described earlier, however, for some health benefits (e.g. blood pressure lowering) clinical trials of exercise intensity suggest similar if not greater benefits from moderate as from vigorous-intensity exercise.” **(op cit p 146)**

We have already seen earlier in this chapter that the clinical trials referred to were very small, of short duration, included only hypertensives and, were, to some degree, inconclusive. In summary, the Report’s arguments appear to have been variously: Volume is the only important factor, and besides, the literature is too imprecise for more exact scrutiny....unless the data happens to suggest that moderate intensity activity provides a superior health outcome.

This pattern of selective interpretation continued when the Report chose to highlight studies **(Leon et al 1987 and Slattery et al 1989)** where small volumes kcal/amounts of moderate intensity activity showed unusually significant reduction in CHD mortality, allowing them to conclude from their interpretation of the literature that:

“Based on these studies, it is reasonable to conclude that activity leading to an increase in daily expenditure of approximately 150 kilocalories/day (equivalent to about 1,000 kilocalories/week) is associated with substantial

health benefits and that the activity does not need to be vigorous to achieve benefit.” **(USSG 1996 p 147)**

There was, the Report suggested, nothing wrong with vigorous intensity activity – but it was represented as not necessary – volume with sustained adherence was the new public health message:

“For some people, a vigorous workout at a health club is the most sustainable choice; for others, activities integrated into daily life (e.g. walking to work, gardening and household chores, walking after dinner) may be a more sustainable option. Periodic re-evaluation may be necessary to meet changing needs across the life span.” **(op cit p 147)**

Having concluded that intensity and duration were essentially equal and interchangeable components of physical activity, the Report then anomalously contradicted itself by choosing, as the first ‘research need’ to distinguish and determine the value of these components after all. That research should:

“Delineate the most important features or combination of features of physical activity (total amount, intensity, duration, frequency, pattern or type) to confer specific health benefits.” **(op cit p 150).**

9.7 Chapters 5 and 6 of the Report : Adherence: Activity Trends, and Behavior

The final two chapters of the Surgeon General’s Report, Activity Trends, and Behavior attempted to identify then current population trends for, and adherence to, leisure time physical activity in the United States.

9.7.1 Activity Trends

As was reported in an earlier chapters, despite repeated and unreferenced claims by the Blair group and other investigators that Americans – and especially the sedentary majority – eschewed vigorous activity but would welcome, take-up, and adhere to a ‘moderate activity health prescription’, the US Government’s own survey results, used in the Report showed no such conclusive evidence.

These indicated that about 22 percent of adult Americans claimed to do ‘regular sustained leisure time activity’ each week (defined as 5+ times/wk at any intensity). This compared with 15 percent who claimed to do regular vigorous leisure time activity at least 3 times a week. **(USSG 1996 p 200)** Even those raw figures suggested that the gap between the number of ‘moderate’ and ‘vigorous’ exercisers was, perhaps

surprisingly, small. Moreover, the gap was not widening and it cannot, in any event, be assumed that all 22 percent claiming 'regular sustained leisure time activity' were exercising at a moderate intensity. Some, at least, will have been performing light activities much of the time – and, of course, some, perhaps a small proportion, of very keen Americans will have been exercising vigorously 5+ times a week. Were both of these groups to have been stripped out the real number of 'sustained moderates' would have been less than 22%.

Moreover, the Report's persistent and systematic attempts to bolster the 'moderate hypothesis' were further (and perhaps accidentally) undermined when, unusually, the merit of vigorous intensity activity was characterised thus: "People who exercise both regularly and vigorously would be expected to improve cardiovascular fitness the most." (**op cit p 181**) Note, the statement stressed not just cardiorespiratory but cardiovascular fitness – a broader and more definitive measure of heart health and protection.

Finally, a slightly deeper look into the reported demography indicated that overall, older adults (45 to 74 years) claimed to exercise more often (and relatively more vigorously) than younger people, giving their reason as having 'greater leisure time': The Report said:

"The finding of generally lower prevalences of regular, vigorous activity among younger than older adults (Table 5-5) may seem unexpected. It is explained partly by both the greater leisure time of older adults and the use of an age-related relative intensity classification" (**USSG 1996 p 184**)

It is to the important issue of perceived leisure time that we finally turn and to the last Chapter 6 of the Report on adherence strategies.

9.7.2 Adherence to Physical Activity

According to the Scientific Editor, Adele Franks, the final Chapter 6: "Understanding and Promoting Physical Activity" – was easily the least rigorous and successful of the Report. It contained no serious attempt to examine, by behavioural theory or any other scientific method, whether the plausible claim that moderate-amount-intensity leisure time activity recommendation would attract greater population adherence than the previous vigorous-intensity guideline. (**personal communication with A Franks, Northampton Massachusetts, May 2007**) Instead, the chapter was largely taken up with theories and models used in social science research about personal motivation

(for example 'self-efficacy') and descriptions of various interventions previously attempted in community and worksite programmes.

Most importantly, even confronted with recent and persuasive adverse evidence (**King et al 1995**) the Report failed to examine the rather obvious fact that its recommendation for the new moderate activity guideline would require individuals to exercise 5, and preferably all days of the week (compared to just 3 times a week for the previous vigorous guidelines) and for a total elapsed time which was more than twice longer (2 ½ hr – 1 hr) per week than the vigorous guidelines. Indeed, when considering why the moderate-intensity lifestyle group in the King and Haskell study scored far worse on adherence than their vigorous intensity subjects, the Report appeared to forecast the damaging flaw in its own advice, without a word of comment or explanation:

“Researchers hypothesize that it was more difficult for the moderate group to schedule 5 days of weekly physical activity than for the vigorous group to schedule 3 days.” (**USSG 1996 p 226**)

9.8 The Report: Summary and Conclusion

Production of the US Surgeon General's Report put physical activity for the first time into the front rank of US public health, along side efforts to lower blood pressure, improve cholesterol profiles and to reduce smoking incidence and prevalence. However, the Report's conclusions were flawed and distorted not only by an incomplete scientific evidence base, but by selective and anomalous interpretation of that data, which arose from several interwoven aspects of its social construction.

While entitled a report on physical activity and health, the Report focused primarily on just two diseases, cardiovascular disease and cancer. Focus on CVD was explicit and understandable given the prevalence and mortality from heart disease and the strong literature base demonstrating the protective effect of physical activity. But preponderant focus was also drawn by the success of Steven Blair and his group in 'enrolling and translating' themselves into influential roles within the American Heart Association which had its own reasons for taking a high profile and influential role in the physical activity debate.

The Report, on several occasions, openly acknowledged its intellectual debt to, and agreement with, the recent findings and recommendations of two highly influential panels CDC/ACSM (**Pate et al 1995**) and **NIH 1996** which considered physical activity and cardiovascular disease. As we have seen, these panels too were heavily

influenced by Blair and his group and their conviction that evidence for their moderate (volume and intensity) hypothesis had falsified the pre-existing vigorous activity recommendations. It is perhaps not surprisingly, therefore, that Steven Blair was chosen to become the Senior Scientific Editor of the Report, working alongside Adele Franks, a staff CDC physician. Blair himself acknowledged that, given his existing and prominent physical activity roles with the American Heart Association and the National Institutes of Health – his selection as the Senior Scientific Editor of the Surgeon General's Report was not surprising. **(personal communication SN Blair, London, October 2007)**

While the primary pressure to devise and implement the new moderate activity 'paradigm' as US public health policy came from the 'internal' influence of Steven Blair and his group, it was clear to Adele Franks that the 'moderate message' was precisely what the politicians and policymakers – principally the Secretary of Health and Human Services (Donna Shalala) and the acting Surgeon General (Audrey Manley) – wanted, in policy terms, to embrace. It is Franks view that both women wanted to accept the notion that the American people suffered from a 'misperception' that only vigorous activity, which deterred them, brought health benefits, whereas the American people would happily adopt and adhere to moderate activities, if only the 'surprising' benefits were explained to them. Franks said:

“That was clearly how this report was sold to the Surgeon General in the first place -- to have her say yes, when they said to her there is a misperception out there and you want to show that there are other kinds of physical activity that the population are more likely to adhere that had health benefits. That's what caught her attention....the misperception that you had to go out there and sweat hard and do vigorous physical activity...but in fact you could take walks, and not sweat and that there was documented health benefits. And that's what persuaded her that this should be worked up into a Surgeon General's Report.” **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Furthermore, Franks said she felt intense (political) pressure from Shalala to complete the Report, no matter how flawed, before the opening of the 1996 Olympic Games in Atlanta:

“The secretary of DHHS [Shalala] wanted the report out before the Olympics and we were already behind schedule and my job was to get this report out on time or heads were going to roll. They needed somebody who

could step in, who could be objective, diplomatic and who could turn this thing around very fast. I said, 'I don't think it's possible to do it this fast'. I also asked almost every division in the Center [CDC] to donate some scientists to help review the papers. Because, after I got into it and started pulling the references, I thought, oh my God, what they are saying isn't even true, based on the references. It was such an exaggeration of the data, so I had every paper reviewed by scientists, to give me a report back on what did this paper really say, and is this a correct statement, or not. I wanted to make sure that each citation was correct for what it was being cited for." **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Moreover, Franks said the 'exaggeration of the data' came persistently from an apparent desire to press the 'moderate message':

"Yes, it was exaggerating the findings in terms of the clarity and certainty of moderate physical activity's health benefits.....It wasn't random error, it was clearly exaggerating the benefits of moderate activity." **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Despite Franks' late interventions, the temptation, selectively to interpret the scientific evidence for each considered health outcome was not always identified and resisted. From its opening political preamble, through its main focus on heart and other disease outcomes, and then on to its final chapters on activity trends and adherence behaviour, the Report systematically played down and misinterpreted the clinical and behavioural record of vigorous activity – while maintaining variously that: total volume of energy expenditure (not intensity) was the key health factor and/or that activities of a moderate 'amount/level/intensity' were as good, and sometimes even better in improving health outcomes.

Such 'selective interpretation' was further revealed by the internal contradiction seen in Chapter 3 of the Report when physiologic responses were examined. Here the 'rate' of activity (intensity) was discussed and "lower rates of work" were said to "place relatively small demands on cardiovascular and respiratory systems..."(**USSG 1996 p 62**), an apparent refutation of the 'moderate/total volume' message that ran throughout the Report.

Further, the Report claimed – in spite of contemporary evidence and comment to the contrary (**Winett RA 1995, Lee et al 1995, Haapanen et al 1996**) that an 'emerging

consensus' on the surprising benefits of moderate activity had been achieved, and this would, when properly promulgated, lead to a big upsurge in adherence – especially from the majority of sedentary Americans.

The Report failed even to discuss Paffenbarger and Lee's then most recent study (**Lee et al 1995**) showing no significant reduction in all cause mortality no matter how great the volume of non-vigorous activity undertaken. And the Report briefly described, but then failed adequately to address, the disquieting evidence (**King et al 1995**) that its preferred public health prescription (5+/wk 30 min brisk walk) would fail because it demanded too many weekly days of adherence among a population which considered itself seriously 'lacking in time'.

The explanation for the fundamental anomalies and inconsistencies in the Report stem directly from the desire of both politicians and policy makers to promulgate a new public health prescription for physical activity which they believed would be more widely accepted, and acted upon, especially by the evidently growing number of sedentary Americans. Steven Blair and his close colleagues, as Ancel Keys had done before them, no doubt acted primarily with the public health in mind when they sought to turn their unproven hypothesis into the 'warranted authority' of proven and verified scientific fact that had come from 'an emerging consensus' of investigators. This social construction of the scientific evidence came, unusually, not from macro-economic economic forces, but internally from within the American academic, scientific and public health communities themselves.

It is to a final examination and analysis of the anomalies of both selection, and interpretation of all the scientific and policy literature, which has already been reviewed chronologically, that we now turn.

Chapter 9: The US Surgeon General's Report

9 Introduction

This chapter examines how, in spite of incomplete and conflicting evidence, the *US Surgeon General's Report on Physical Activity and Health* declared an 'emerging consensus' supporting the new moderate activity 'paradigm' that had been 'constructed' in the years preceding its publication in July 1996. It further examines, chapter-by-chapter, how evidence was selectively chosen, presented, interpreted, distorted – and at times inexplicably ignored in ways designed apparently to support and defend the US government's public health policy decision to shift guideline emphasis entirely away from vigorous intensity activities in favour of activities of moderate intensity, but of longer duration. It focuses on the extensive coverage given to two diseases (cardiovascular disease and cancer) to the relative exclusion of other health outcomes and the roles played by the American Heart Association and Steven Blair and his close colleagues in shaping its construction.

As a result the overwhelming message of the 300 page public health document was to over-play the value of relatively small amounts ($\approx 1,000$ kcals/wk) of moderate intensity activity. That value was exaggerated not only in the specific health benefits that this kind of physical activity might provide, but also by implicit and explicit estimation of the greater long-term adherence to the 'moderate recommendation' by an increasing percentage of the American public. To emphasise this moderate message, the Report went further to minimise the importance of more vigorous activities by suggesting that many people disliked them and, in any event, total volume of activity (kcals expended) rather than its intensity (kcals/min) was the key to health benefits. Thus, vigorous activity was 'demoted' and most frequently portrayed as an optional and largely unnecessary goal – especially for the majority of Americans who were sedentary or only occasionally active and who would be least likely, it was argued, to maintain adherence to such an arduous regime. At the same time, little, if any, substantial evidence was provided to support what seemed to be the plausible assumption that less strenuous activity might be more attractive, even if the time and frequency demanded was substantially greater for a population with a common perception that it already lacked sufficient time for leisure time physical activity pursuits.

These interpretations were apparently well intentioned, but nevertheless socially constructed from assumptions (whether implicit or explicit) that caused the scientific

evidence to be selectively chosen and misinterpreted. The Report's fundamental conclusion and recommendation became all the more problematic because it emerged as a simplified, and indeed, simplistic single message – 5 or more brisk walks for 30 minutes each week – which rapidly became the largely unchallenged public health mantra not only in the United States, but throughout Europe and the rest of the developed world.

In many other respects, however, the Report makes a thorough and un-contentious attempt to assess, interpret and explain the broad and beneficial 'physiologic' impact of all physical activity on human health. Also, in the second chapter (Chapter 2), which is discussed only briefly here, it provided an excellent overview of the history and terminology of the study of physical activity and of previous public health recommendations. Above all, the Report's publication from the US Surgeon General's office has ensured that greater prominence and importance have been given to the role of physical activity as a primary tool of public health policy in the United States and elsewhere. Much of the credit for that success appears to belong to Dr Adele Franks, a public health physician at the Centers for Disease Control and Prevention who was drafted in to work alongside Steven Blair to ensure that the Report, in its final form, was approved after inter-agency scrutiny, for publication. **(personal communication with SN Blair, London, September 2007; A Franks, Northampton Massachusetts May 2007, T Bazzarre, Princeton, New Jersey May 2007)**

FOIA Request: Absence of Background 'Grey Matter' Material for Triangulation

One of the greatest limitations of this study has been the absence of any of the unpublished policy materials – the 'grey matter' of memos, drafts and other background documents – that were written during the planning, drafting, production and editing of the US Surgeon General's Report. Repeated requests via the formal US Freedom of Information Act Procedure **(US FOIA)** yielded not a scrap of evidence (unlike a similar request for background data surrounding and relating to the National Institutes of Health Consensus Conference (December 1995) where a substantial amount of information was obtained).

There is strong evidence to suggest that all of these unpublished policy documents were destroyed during an internal reorganisation at the Centers for Disease Control and Prevention (CDC) in Atlanta shortly after the Report was published. Michael Pratt, the most senior official still at the CDC who played a role in the Report's production said:

“I’m afraid pretty much all of that stuff was trashed years ago. We have file cabinets, but they only contain, as far as I am aware, copies of the cited scientific journal reports that went into formation of the Surgeon General’s report. One of the biggest reasons that records don’t survive is that the division of nutrition and physical activity did not exist when the Report was prepared and published. So internal re-organisation meant lots of things were thrown away.” **(personal communication with Michael Pratt January 2007)**

The Report was prepared and published before the era of email communication, and the internet was only upon the cusp with the introduction of Windows 1995, the software which fully ushered computer technology into everyday life. If floppy discs of information were made, these have apparently been lost too, along with the hard drives of old desktops long ago discarded in a decade still coming to terms with the new technology and the importance of keeping its electronic historical records.

Dr Pratt’s opinion was confirmed by Adele Franks, the scientific editor of the Report, who oversaw all the later steps of its preparation and publication. On a visit to the CDC in the Spring of 2007 she kindly made renewed attempts to uncover any of this background data, and was again, unsuccessful. She did, however, find the ‘file cabinets’ described by Dr Pratt and provided this author with an extensive list of their contents. Unfortunately, they did contain only the published scientific journal reports that the authors of the Report relied upon. This catalogue cannot directly reveal which documents weighed heavily (or not) in influencing the key elements of the Report’s findings. But it can, at least indicate which key documents are no longer stored, and which were therefore probably never gathered or evaluated in the Report’s deliberation. Thus, it has been all the more important extensively to interview the key individuals who played the most influential roles in the Report’s planning, preparation and publication, not least its two editors, Adele Franks and Steven Blair.

Haapanen et al 1996

Further contemporary evidence had begun to emerge from a group of well respected Finnish investigators that the scientific evidence in 1996 remained conflicting, uncertain and/or incomplete. The Finnish team, led by Haapanen and Vuori, published their concerns, not in an obscure European journal, but in the American Journal of Epidemiology in early May 1996, while the US Surgeon General’s Report, published in late July, was still in preparation.

Their assessment came in the introduction to their own 10 year follow-up study (**Haapanen et al 1996**) on the association between leisure time physical activity, all-cause, and cardiovascular disease mortality among a cohort of 1,072 Finnish men aged 35-63. The authors commented directly on how uncertain and conflicting was the epidemiologic literature on the relative importance of intensity, duration and total volume of energy expenditure on these health outcomes:

“Despite extensive evidence indicating an apparent protective effect of leisure time physical activity for both cardiovascular and all-cause mortality, the existing epidemiologic studies yield somewhat conflicting results about the nature of physical activity needed to achieve preventive effects against cardiovascular disease and all-cause mortality. Based on current knowledge, the relative contributions of the frequency, intensity, duration and type of physical activity in reducing the risk of cardiovascular diseases and death are difficult to determine. Some studies suggest that only rather high intensity exercise is effective (**Morris et al 1980, Morris et al 1990, Lakka et al 1994**), while others suggest that moderate activity is sufficient to reduce risk (**Leon et al 1987, Leon et al 1991, Paffenbarger et al 1986**). A similar discrepancy is found in studies concerning the association between physical fitness and coronary heart disease or total mortality. In some studies, there seems to be a consistent, graded relationship between physical fitness and mortality (**Lakka et al 1994, Ekelund et al 1988, Sandvik 1993**), while other studies [sic] show that the most significant difference in mortality risk seems to occur between the lowest and next lowest fitness categories.” (**Haapanen et al 1996 pp 870-71**)

In fact, **Leon et al 1991** was not a new cohort, but simply an extension of the **Leon et al 1987** study discussed at length earlier in Chapters 7 and 10. Furthermore, Haapanen and Vuori cited only a single study with this last concave, curvilinear and asymptotic evaluation: Blair et al 1989. They went on explicitly to underline this conflict and uncertainty:

“For this reason, more convincing data are needed to reveal the kind of physical activity required in terms of the type, intensity, and frequency of exercise sessions, as well as the total weekly energy expenditure in exercise, to achieve the preventative effects of physical activity on overall and cardiovascular disease mortality.” (**Haapanen et al 1996 pp 870-71**)

Thus Haapanen and colleagues appeared to suggest that no substantial revision of public health guidelines for physical activity would be wise and prudent until ‘more

convincing' data – not least on the importance of intensity – became available, from a more thorough and balanced literature review – and from new intervention and epidemiological studies.

9.1 Political/Public Health Policy Preamble: Moderate 'Intensity-Amount Level' Messages

That stark assessment of the continuing uncertainty within the 'intensity debate', was hardly reflected in the opening remarks which American politicians and public health policy makers chose to make and place prominently in the preamble to the US Surgeon General's Report. The then Secretary of Health and Human Services, Donna Shalala proclaimed that American scientists had, in the 1980s and 1990s, "made breakthrough findings about the health benefits of moderate-intensity activities such as walking, gardening and dancing." **(USSG 1996 p i) (emphasis added)** Shalala told Americans:

"A regular, preferably daily regimen of at least 30-45 minutes of brisk walking, bicycling, or even working around the house or yard will reduce your risks of developing coronary heart disease, hypertension, colon cancer, and diabetes." **(op cit p i)**

She did not entirely exclude more vigorous intensity activity from her exercise prescription, but she appeared to repeat the core argument of the 'moderate modernisers' that an extra daily dose of additional moderate activity would be, in terms of health improvement and disease reduction, equal too and indistinguishable from, the improved health profile of vigorous intensity activities. Thus total volume (kcal of expenditure) and not intensity of activity was the key to health benefits:

"And if you're already doing that, you should consider picking up the pace: this report says that people who are already physically active will benefit even more by increasing the intensity or duration of their activity." **(USSG 1996 p i)**

By this logic, therefore, Americans could choose equally between a shorter, intense jog – or a longer moderate walk – and achieve identical, additional health benefits because intensity and duration of physical activity were physiologically inter-changeable. Intensity, in and of itself, was not important.

This 'equal to and indistinguishable from' interpretation was echoed in a similar opening message from Dr David Satcher, director of the CDC (Centers for Disease Control and Prevention): Alluding to the 1996 Olympic Games, which were about to begin in Atlanta, he again re-assured Americans:

“The good news in this report is that we do not have to scale Olympian heights to achieve significant health benefits. We can improve the quality of our lives through a lifelong practice of moderate amounts of regular physical activity of moderate or vigorous intensity.” **(op cit p iii) (emphasis added)**

Intensity or duration, moderate or vigorous....both the Health Secretary and the director of the US Government’s most important public health body were telling Americans that, in effect, the intensity debate was over. American scientists had apparently proven that moderate intensity activity was every bit as good...in every respect.

It’s instructive, however, to note that Shalala and Satcher did not manage to agree on their terms of measurement – or at least their scriptwriters could not. Shalala used the relatively clear definition ‘moderate intensity’, while Satcher chose the ambiguous ‘moderate amounts’. The imprecision was compounded further by the acting Surgeon General, Dr Audrey Manley when she chose: “The good news in the report is that people can benefit from even moderate levels of physical activity.” **(op cit p v) (emphasis added)**

9.2 Chapter 1 of the Report: Introduction, Summary and Chapter Conclusions

Bearing in mind that the Report stretched to 300 pages, it was likely that the ‘executive report’ – of its introduction, summary and chapter conclusions (Chapter 1) would be the most that would be absorbed and communicated by the media and by most other methods of dissemination. It was here that the emphasis on the benefits of moderate activity – and the ‘unnecessary discomfort’ of more vigorous intensity activities – is most evident. The chapter’s opening paragraphs are therefore quoted at some length. Once again, the terms intensity, amount, and level are used with evident imprecision.

“This is the first Surgeon General’s report to address physical activity and health. The main message of this report is that Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily lives. Health benefits from physical activity are thus achievable for most Americans, including those who may dislike vigorous exercise and those who may have been previously discouraged by the difficulty of adhering to a program of vigorous exercise. For those who are already achieving regular moderate amounts of activity, additional benefits can be gained by further increases in activity level.” **(op cit p 3) (emphasis added)**

The argument that doing some physical activity is better for human health than being entirely sedentary was hardly contentious. But as we have seen, the claim that 'moderate amounts' produce substantial improvements was both uncertain and contentious on two grounds: First the terms 'amount' and 'substantial' lacked precise definition, implicitly assuming that the two components of amount – intensity and duration – were interchangeable. Second, as Haapanen and Vouri (**Haapanen et al 1996**) succinctly summarised, the most recent and authoritative evidence from epidemiologic studies remained uncertain, and indeed conflicting, in failing solidly to support Blair's ACLS data that the greatest health benefits were found between the least fit and those who were just a bit fitter – in essence, the primary evidence, from a single study (**Blair et al 1989**) that gave support for the 'moderate amount – substantial benefit' claim.

Indeed, Haapanen and Vouri did not cite, and thus may have submitted their article too early, to have had the advantage of seeing Paffenbarger's latest data from the Harvard Study (**Lee et al 1995**) indicating quite the opposite, and conflicting result: that without inclusion of some vigorous intensity 'strenuous' activity, no amount (total kcals of expenditure) of non-vigorous activity was significant in reducing all-cause mortality. However, the authors of the US Surgeon General's Report failed even to consider this crucial paper that was so central to the debate. This omission is inexplicable, not least because Paffenbarger was universally regarded as the American doyen of his field and Dr Lee, was his able and admired colleague and collaborator. Furthermore, the paper was published on April 19, 1995 in one of the two most influential and widely read American medical journals, the *Journal of the American Medical Association* (**JAMA**). Yet it did not appear in the text of, or in the references to, the US Surgeon General's Report, even though Lee herself served as one of the 'contributing authors' to the Report. What is more, other (and often less relevant) articles published after it, and in less prominent journals, were included and referenced in the Report. For example, in the substantive Chapter 4 of the Report (*Effects of Physical Activity on Health and Disease*) alone, no fewer than 39 articles published in 1995 were cited and at least 8 published in 1996, not least Oliveria et al 1996, a paper co-authored by Steven Blair. See also for example: Ching et al 1996; Kirchner et al 1996.

The claim that some Americans might dislike and also find difficulty in adhering to a 'vigorous activity program' also needs further examination. No doubt some Americans disliked vigorous activity. But where was the evidence that they greatly preferred moderate activity and would adhere to such programs or 'lifestyles' more conscientiously? The contemporary US Government Surveys discussed in the previous

chapter (Chapter 8) showed similar results of regular adherence to both intensities. Moreover, the US Surgeon General's Report also had the thorny problem of addressing the results of the biggest, longest lasting and most authoritative intervention trial on physical activity ever constructed in the United States, the results of which had only just been published the previous year. As we have seen, the two year trial by Haskell and King (**King et al 1995**) set out to substantiate their assumption that middle aged American men and women would adhere far better to 'moderate intensity lifestyle activities' than to vigorous intensity performed in a group in a gym, or alone, incorporated into their own lifestyles at home. Yet, the best adherence was maintained by the 'vigorous lifestyle' group, while the 'moderate intensity lifestyle' group performed almost as badly as the vigorous gym based group. Moreover, Haskell and King directly observed that the reason for the 'moderates' relative adherence failure could be explained in their difficulty in adhering to a program that required 5 x 30 minutes lifestyle activities a week – the very regime that the US Surgeon General's Report was now proposing as the primary and fundamental plank of its public health recommendations.

Further, the Report's authors and editors cannot claim not to have seen, and indeed to have examined King et al 1995. Not only was King herself a 'contributing author' to the Report, but the findings of her paper with Haskell were mentioned in some detail in the final chapter of the Report itself, where the issues of behavioural adherence were directly addressed. (**USSG 1996 p 226**)

The extent of the incompleteness of, and conflict within, the evidence – was simply downplayed or ignored as the introduction to the Report continued with apparent upbeat self-confidence:

“This report grew out of an emerging consensus among epidemiologists, experts in exercise science, and health professionals that physical activity need not be of vigorous intensity for it to improve health. Moreover, health benefits appear to be proportional to amount [sic] of activity; thus, every increase in activity adds some benefit.” (**op cit p 3**)

Did this 'emerging consensus' literally mean any increase in activity, no matter how low its intensity, short its duration, and small the total volume (kcal) of energy expenditure? Once again, no evidence or citation was given to support the highly contestable assertion that 'amount' measured by total calories alone, regardless of the intensity of the expenditure, yielded this linear improvement in 'health benefits'.

The Report did, however, at least avoid asserting the declaration of a moderate 'physical activity – health paradigm' originally drafted by Blair and Pate and proclaimed by the US Centers for Disease Control (CDC) and American College of Sports Medicine in their 1995 consensus report (**Pate et al 1995 p 405**).

“Emphasizing the amount rather than the intensity of physical activity offers more options for people to select from in incorporating physical activity into their daily lives. Thus, a moderate amount of activity can be obtained in a 30 minute brisk walk, 30 minutes of lawn mowing or raking leaves, a 15 minute run, or 45 minutes of playing volleyball, and these can be varied from day to day.” (**USSG 1996 p 3**)

This somewhat more balanced tone more closely mirrored the more measured words of the National Institutes of Health (NIH) Consensus Report 1996, where Blair and Pate played prominent roles, but where they were prevented by NIH rules (that excluded known 'strenuous advocates') from serving on the consensus panel which actually drafted the report. (**NHLBI bundle 05-30-95**)

Nevertheless, the clear and explicit emphasis remained upon moderate amounts of moderate intensity activity based on the unproven assertion of 'volume theory' – that intensity and duration were interchangeable – that all kcals of energy expenditure were equal in their beneficial impact on health. (**Winett RA 1995**)

9.2.1 Basic Physiologic Evidence is discounted or omitted

This 'volume theory' was not only in direct conflict with then contemporary exercise physiology science (**McArdle et al 1996, Westcot W 1995**). It was also contradicted within the Report itself. Located rather more obscurely in the un-contentious chapter on physiologic responses (Chapter 3: Physiologic Responses and Long-Term Adaptations to Exercise) was this statement:

Low rates of work, such as walking at 4 kilometres per hour (2.5 miles per hour) place relatively small demands on the cardiovascular and respiratory systems...With few exceptions, the cardiovascular response to exercise is directly proportional to the skeletal muscle oxygen demands for any given rate of work, and oxygen uptake (VO_2) increases linearly with increasing rates of work.” (**USSG 1996 p 62**)

Yet this clearly conflicted with the 'moderate-volume' theory -- at the very centre of the US Surgeon General's Report – and was not chosen to be highlighted in the 'bullet points' of that chapter conclusions, and thus it also did not appear in the prominent,

summarising 1st Introductory chapter of the Report (Chapter 1) where these ‘bullet points’ from all chapters of the Report were gathered together and repeated.

Instead, the introductory chapter emphasised a belief in an ‘emerging consensus’ about the benefits of moderate intensity activity, especially (but not exclusively) for the sedentary who lacked the stamina and will power to be more vigorous:

“As understanding of the benefits of less vigorous activity grew, recommendations followed suit. During the past few years, the ACSM, the CDC, the AHA, the PCPFS [President’s Council on Physical Fitness and Sport] and the NIH have all recommended regular, moderate-intensity activity as an option for those who get little or no exercise.” (op cit p 5)

These prescriptions were not targeted exclusively at the sedentary. Moderate intensity activity was represented as the general headline public health recommendation first by the **AHA (1992)** and then by the **CDC/ACSM (1995)** and then by the **NIH (1996)** (see Chapter 8). Further, what this collegiate statement concealed, or at least obscured, was that this ‘emerging consensus’ of opinion was largely the consensus of just a few investigators led by Steven Blair, Russell Pate, Carl Caspersen and to a lesser extent William Haskell and Ralph Paffenbarger. The PCPFS was, and remains, largely a ceremonial body with little independent clout. All the other agencies – the ACSM, the CDC, the AHA and the NIH had all been powerfully influenced (see Chapter 10) by the representation, evidence and opinions of Steven Blair and Russell Pate, leaders of the ‘moderate persuasion’, who also believed, with little if any evidence, that the American public, while keen and well intentioned, was nevertheless particularly poor at adhering to and benefiting from vigorous activities, as the Report continued: “Moreover, although many people have enthusiastically embarked on vigorous exercise programs at one time or another, most do not sustain their participation.” (**USSG 1996 p 5**)

9.3 Chapter 2 of the Report: Historical Background and Evolution of Physical Activity Guidelines

The Report strove, in many respects to provide a balanced account of the impact of physical activity upon health and disease prevention. Yet, even in the least contentious chapters (Chapters 2 and 3), which chronicled the historical evolution of physical activity guidelines and the physiologic response to exercise, the text evidently (over) emphasised the health benefits and ease of adherence of moderate intensity activity. But the language was often more sober and balanced and is summarised briefly, here:

“Numerous expert panels, committees and conferences have been convened over the years to evaluate the evidence relating physical activity and health....Specific exercise recommendations have emphasized only vigorous activity for cardiorespiratory fitness until recently, when the benefits of moderate intensity physical activity have been recognized and promoted as well.” **(op cit p 37)**

9.3.1 Moderate Intensity Guideline Becomes US Government Policy

In evident reference to the recent consensus conferences **(CDC/ACSM Pate et al 1995 and NIH 1996)** the Report said:

“The most recent recommendations advise people of all ages to include a minimum of 30 minutes of physical activity of moderate intensity (such as brisk walking) on most, if not all, days of the week. It is also acknowledged that for most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or of longer duration.” **(USSG 1996 p 37)**

Thus, the new moderate intensity hypothesis had now emerged as the official policy of the US Surgeon General and therefore as the primary physical activity public health message of the US Government. Recommendations to exercise vigorously had been not only de-emphasised, but had been all but discarded – except for the energetic few who actually enjoyed more strenuous activity. The same ‘greater health benefits’ (gained from exceeding the 5 or more weekly 30 minute brisk walk regime) could equally be achieved by doing just more of the same (‘longer duration’). This ‘emerging scientific consensus’ – this new ‘health paradigm’ -- had been officially endorsed by the American authorities and the message would rapidly spread to Britain and the rest of the world. Intensity and duration were interchangeable in public health terms. Vigorous activity was effectively deemed irrelevant. Or was it?

9.4 **Chapter 3 of the Report: Physiologic Responses to Exercise**

9.4.1 The ‘Rate’ of Activity Does Matter

The key notion that longer duration of moderate intensity activity could deliver the same health benefits as shorter bouts of more intense exercise was contradicted when the Report turned to the important scientific issue of how, precisely, does the human body react physiologically to various ‘doses’ of physical activity. We have also seen how the politicians and policy makers quoted in the preamble to the report used various imprecise and conflicting modifiers (intensity, amount and level) while asserting the

benefits of 'moderate' activity – itself a poorly defined term. As we have seen above, the authors of Chapter 3 introduced a fourth, new and rather more precise word – 'rate' - more accurately to describe the effect of an activity's intensity on the body's physiologic response: The result was that 'rate' appeared to be a precise measure of intensity (taken from maximal oxygen uptake $\text{VO}_2 \text{ max}$) – and indeed, different 'rates' of activity did elicit different physiologic responses:

“When challenged with any physical task, the human body responds through a series of integrated changes in function that involve most, if not all, of its physiologic systems.” (**op cit p 61**). Those listed were musculoskeletal, cardiovascular, respiratory, endocrine and immune systems. Further: “The magnitude of these changes depends largely on the intensity and duration of the training sessions, the force or load used in training, and the body's initial level of fitness.” (**op cit p 61**).

Thus, intensity and duration were described as quite distinct phenomena. The authors did not say: *Intensity or duration*.

9.4.2 Effect of Relative Fitness

It was explicitly recognised by the Report that any given 'force or load used in training' might have elicited quite different physiologic responses from a sedentary individual than from a fit one. Hence Morris' hypothesis (**see Morris et al 1973, 1980, 1990, Morris JN 1992**) might well have proved accurate for his relatively fit British civil servants, who received significant heart attack risk reduction from vigorous activity (but very little or none from more moderately intense activities). Whereas more sedentary American populations might very much display significant disease or mortality risk reduction from less vigorous activities (**Paffenbarger et al 1993**), or from only modestly better degrees of fitness compared to those who were even more unfit. (**Blair et al 1989**) Here then might be at least some explanation for the conflicting results of Morris, Blair and Paffenbarger over the key issue of the medical and public health importance of exercise intensity.

It is important to note that the Report asserted that an increased 'rate' or intensity of activity improves not just narrow cardiorespiratory fitness – but improves the wider 'cardiovascular response' as well. (**USSG 1996 p 62**) Supporters of the moderate hypothesis recognised, in most cases, that more vigorous activity was better at improving cardiorespiratory fitness, but they often attempted to argue that moderate activities were as good, or even better, at improving cardiovascular risk factors, not least with levels of HDL cholesterol and blood pressure.

9.4.3 Immune Responses to Exercise

By 1996 it had been fairly well established that activities that combined both vigorous intensity and extreme duration (for example, and most commonly, training for and running a marathon) were actually damaging to the human immune system. The authors of Chapter 3 duly noted this adverse response to 'overtraining'. **(op cit p 67)** However, by contrast they observed:

“Moderate exercise has been shown to bolster the function of certain components of the human immune system – such as natural killer cells, circulating T and B lymphocytes, and cells of the monocyte-macrophage system – thereby possibly decreasing the incidence of some infections.”
(op cit p 67)

Can it have been a mere oversight, however, that the authors of Chapter 3 failed to define whether by “moderate exercise” they meant exercise of moderate intensity, or moderate durations of more vigorous activity? Once again imprecise wording, at the very least, left room for ambiguity, which was exploited rather than made explicit and clarified.

9.4.4 Hormonal Response

Broadly, the Report concluded that physical activity beneficially alters the human hormonal system. However, its evidence base appears to have been taken and adapted from a single table **(Wilmore JH and Costill DL 1994)** which itself had apparently been compiled from short-term exercise physiology studies which would have been conducted at relatively high intensity among healthy adults. Thus, little if anything can be drawn from the fact that almost all of the beneficial hormonal responses were reported after 'intense exercise' or 'training'. In one study, however, intensity comparisons were made. The hormone ACTH-cortisol, which beneficially increases gluconeogenesis in liver and increases mobilisation of fatty acids reacted thus: “Greater increase with intense exercise; increases less after training with submaximal exercise.” **(op cit p 68)**

However this differential intensity outcome was not examined in the text of the Report. In the summary of research needs at the end of Chapter 3 the Report made no recommendation to discover the relative importance of intensity, duration and frequency of physical activity in improving pre-determined physiologic responses. Once again the loose language ('amount') of their request was imprecise and ambiguous: “Determine the minimal and optimal amount of exercise for disease prevention” **(op cit**

p 77) – apparently another implicit acceptance of the contentious ‘volume’ hypothesis as robust scientific fact.

9.5 Chapter 4 of the Report: The Effects of Physical Activity on Health and

Disease

The Surgeon General's Report described itself as a broad examination of the effect of, not just structured exercise, but all physical activity upon human health. However, its predominant focus was upon the impact of moderate intensity aerobic activity (to the relative exclusion of vigorous intensity aerobic activity and of resistance (weights or muscular strength) training. Moreover, its predominant health focus was on cardiovascular disease (CVD), with other health outcomes/diseases evidently given much less coverage.

Why were these foci chosen? We have examined at length the so-called ‘emerging consensus’ that powered the argument for the under-examined or under-valued benefits of moderate intensity activity. But did the focus on cardiovascular disease (primarily CHD and stroke) arise simply because of the association between it, as the leading cause of death, and physical activity, as a major a risk reducer, was both strongest and longest? Or were other factors also at work?

9.5.1 Focus on Cardiovascular Disease and Cancer

First, it should be recalled that the landmark US Government-funded *Framingham Heart Study*, which began in 1948, first identified physical (in)activity as a major risk factor in cardiovascular disease in 1967 (**Kannel WB 1967**) – nearly two decades before extensive examination of similar (causal) links with other important diseases were being seriously investigated. Second, the importance of physical activity and structured exercise as a recovery tool for rehabilitation of heart disease patients had also been well established. Third, and concomitantly, the medical literature on physical activity and health had been overwhelmingly focused on cardiovascular disease. **(personal communication with KE Powell, Atlanta, Georgia and A Franksn Northampton, Massachusetts May 2007)**. Indeed, this was made explicitly clear in the introduction to Chapter 4: of the Report which said:

“The primary focus is on diseases and conditions for which sufficient data exist to evaluate an association with physical activity, the strength of such relationships, and their potential biologic mechanisms....The majority of population-based research in the area of physical activity and health has focused on some aspect of CVD.” (**USSG 1996 p 85 & 87**)

Within Chapter 4 of the Report, a total of 56 pages were given to analysis of the impact of physical activity to specific diseases and health outcomes. While allowing for some page overlap, the number of pages given to each (and its order of presentation), is listed below:

<u>Health Outcome/Disease</u>	<u>Page Coverage</u>
Overall Mortality (includes CVD)	1
Cardiovascular Diseases	26
Cancers	12
Type 2 Diabetes (NIDDM)	4
Osteoarthritis	2
Osteoporosis	3
Obesity	2
Mental Health	6

It is beyond the scope of this dissertation fully to examine this balance of health outcomes coverage, or indeed to look in depth at the evidence presented for the protective benefits of physical activity other than for cardiovascular disease. But several observations need to be made.

First, the extent of coverage given to each outcome may, to some extent, have also reflected opinion within the CDC about public perception of the prevalence and importance of each disease, and not merely the known benefits (or size of) the existing physical activity literature associated with it. It has been argued, for example, that the American public's fear of cancer was and is, for complex reasons, substantially greater than that of the British public's and that therefore Americans have expected their public health and environmental agencies to take greater care to investigate ways to prevent it. **(Gillespie et al 1982 pp 322, 325-27)**

Nevertheless, with the single exception of colon cancer, the scientific literature of the period did not suggest a clear beneficial association with physical activity. At best, for other cancers the literature showed mixed results and were thus inconclusive in suggesting that physical activity (of any intensity or duration) was protective against any other forms of the disease. Yet, in the final Report 12 pages were devoted to

analysis of cancer which yielded very little, even after it had, apparently, been stripped of what might be described politely as un-rigorous over-enthusiasm for the protective benefits of physical activity. According to Adele Franks, who asserted that she was brought in at a late stage to rescue the Report:

“I believe that we drastically changed and shortened and eliminated some whole chapters with other [than CVD] health outcomes that just weren’t supported [by the scientific evidence]. The cancer chapter was a disaster. We had to peel that one way back. I believe obesity was horrible and we had to peel that one way back too.” **(personal communication with A Franks, Northampton, Massachusetts May 2007).**

Franks’ observation suggests that the ‘public health enthusiasm’ of some physical activity investigators invited to work on the Report may have led them to attempt to draw positive conclusions about the effective benefits of physical activity that were simply unsupported, or insufficiently supported by the available scientific evidence in the literature.

The exceptional, and arguably anomalous prominence of the American Heart Association (AHA) in formulating US public health policy on physical activity in the 1990s will be examined in some depth in Chapter 10, and so shall only be summarised here. Between 1990 and 1996 the AHA launched a flurry of position papers, workshops, conferences – and indeed a ‘strategic plan’ (with it at the helm) aimed at improving the public health profile of physical activity, and particularly moderate intensity activity. It was during this period that Steven Blair and close colleagues such as Russell Pate and Carl Caspersen gained influence and important roles within the AHA. The association’s lobbying influence, and particularly its decision to spearhead a strategic plan that would allow it to act as an umbrella for other charities and pressure groups evidently impressed senior officials at CDC. Michael Pratt recalled:

“Yes, the links and literature on CVD were much greater and longer (than for other diseases). The AHA had just produced, in 1994, its strategic plan for physical activity, ranking it up with smoking, blood pressure and cholesterol. The focus was very much on CVD, by comparison, other diseases were pretty much added on.” **(personal communication with M Pratt, January 2007)**

Pratt also confirmed that the only person outside of government or an academic institution who played a senior role in the Report’s construction was Terry Bazzarre,

head of physical activity and nutrition at the American Heart Association, who was himself a close friend of Steven Blair.

So it would appear that the explicit and entirely understandable emphasis on cardiovascular disease was enhanced by the alliance between Blair's group of investigators, the AHA and senior people at the CDC including Michael Pratt and Ken Powell. Exactly who and what might then have benefited from this liaison? First the American Heart Association, itself.

9.5.2 The American Heart Association (AHA)

Chapter 10 will draw further upon the work of Karin Garrety to examine how the AHA grew suddenly and exponentially in the 1950s into a powerful fund raiser for, and exponent of, heart disease research. It was able therefore to establish close links with the *Framingham Heart Study* and thus its funding body, the National Heart, Lung and Blood Institute at the US Government's National Institutes of Health (NIH). Indeed, the bibliography from the *Framingham Heart Study* shows that a high proportion of its studies were, and continue to be published in *Circulation*, the primary journal of the AHA. Yet, even though the Study had declared physical inactivity to be a major heart disease risk factor in 1967, the AHA had not until the 1990s established important links with the physical activity unit at the CDC, even though this had been set up by Powell in 1983. **(personal communication with KE Powell, Atlanta, Georgia May 2007)**

But by the early 1990s the AHA began quickly (as was explored in Chapter 8) to become heavily involved in the physical activity and public health debate and was thus in a strong position to lead the external pressure to conceive a Surgeon General's Report. Having been persuaded by Blair and his group of the benefits (health and adherence) of moderate intensity activity as a general health prescription, the AHA would have been eager to get their man, Bazzarre, on to the planning board of the Report to ensure that the 'moderate message' was emphatically adopted and promulgated: Terry Bazzarre recalled:

"I had the opportunity to review the full report, and to provide comments about the science, [and] comments about the extent to which there were any contributions from the AHA [that could be made] to that science." He added: "As the publication date [of the Report approached] we hoped we [at the AHA] could release [the findings] in advance. We also realized we

needed to find partners who shared our values. We were building and strengthening relationships with the CDC, with the ACSM [American College of Sports Medicine] and others. So I was there when the National Coalition for Promoting Physical Activity [conceived in the AHA Strategic Plan 1994] began to make sense.” **(personal communication with T Bazzarre, Princeton, New Jersey May 2007)**

9.5.3 The Centers for Disease Control (CDC)

The CDC took little interest in the disease prevention effects of physical activity until Ken Powell succeeded in setting up the Behavioral Epidemiology and Evaluation Branch (BEEB) in 1983 – the primary responsibility of which was “the epidemiologic study of physical activity”. **(Powell and Paffenbarger 1985 p 118)**

Powell had trained as a physician but almost immediately preferred public health to clinical practice and joined the CDC in the 1960s working in the conventional prevention area of the time, infectious diseases. A keen runner, Powell began to examine the work of Paffenbarger and other early investigators and then to question why physical activity was not seen, on a par with smoking cessation, nutrition and alcohol moderation as an important environmental factor in disease prevention. Powell said:

“Resistance at first within the CDC was actually quite considerable to physical activity – not within our immediate hierarchy, but certainly within the divisional and central level.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

Powell advertised for an exercise physiologist with an interest in public health and hired Carl Caspersen who, in turn, introduced him to Steve Blair. Together with Paffenbarger they conceived the landmark workshop in 1984 on Epidemiologic and Public Health Aspects of Physical Activity which drew together the few experts in the nascent field from all over of the United States. With hindsight a direct line can be seen between that first workshop and the CDC/ACSM conference **(Pate et al 1995)**, the NIH consensus conference **(NIH 1996)** and the Surgeon General’s Report itself.

Powell believes that the early public health focus on cardiovascular disease was both necessary and appropriate:

“I don’t think the emphasis on CVD was poorly placed....we only had four people in this unit (BEEB) and so we were not going to mount huge investigations into umpteen outcomes especially when, as far as we could

tell, the only outcome with much supportive evidence was CVD. When you put that together with the fact that CVD is the single largest cause of death in the United States -- that made a lot of sense to us that we should focus on it.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

Powell said he recognised at the outset that the support of some broadminded cardiologists, especially those with influence within the AHA, would be crucial in boosting physical activity’s reputation as a front rank public health prescription:

“No one else was thinking along those lines except some cardiologists. Heart disease was the big killer, and the evidence, such as it was, seemed to be the best, so that seemed to be the appropriate arena to go in....at that time, in 1983, there was in the scientific community not [even] a solid consensus that physical activity reduced the incidence of coronary artery disease.” **(personal communication with KE Powell, Atlanta, Georgia, May 2007)**

9.5.4 The Prominent Role of Steven Blair and His Group

The emerging bridge between the CDC and the AHA was Steven Blair and other close colleagues including Carl Caspersen and Russell Pate. In the language of Garrety, they ‘enrolled and translated’ their way into powerful positions within the AHA. **(Garrety K 1997 p 727)**, just as Ancel Keys had done two decades earlier in a successful effort to turn his unproven cholesterol hypothesis into ‘warranted’ medical orthodoxy. Now Blair and his group would seek to win the same stamp of ‘warranted authority’ from the AHA for their moderate-intensity hypothesis and -- go even further. Attempts by Keys and his colleagues to get a US Surgeon General’s report on cholesterol foundered. According to Bazzarre, drafts of a cholesterol report were started, but internal disagreements among participants and factions led to it being shelved. **(personal communication with T Bazzarre, Princeton, New Jersey May 2007)**

The US Surgeon General’s 1996 Report on Physical Activity and Health would not only be published – but it would very much endorse and promulgate the moderate-intensity public health prescription championed by Blair and his colleagues. This outcome was beneficial to Blair and his group in several ways. There can be no question but that the primary motive of these investigators appears to have been to improve the public health. **(Blair and Paffenbarger 1992, Powell and Blair 1994, Pate et al 1995)**. They also undoubtedly believed, with considerable justification, that the dangers of sedentary living, and the benefits of regular physical activity as a disease prevention prescription

had been substantially undervalued and thus ‘undersold’ to the American public by the more established elements of the public health community. They hoped that the power and influence of a full US Surgeon General’s Report would go far in addressing that imbalance. In parallel, of course, this redress could only enhance the reputations of their disciplines, their institutions and themselves as individual academics and public health advocates. Finally, they also believed (albeit with incomplete and conflicting evidence) that the new moderate-intensity recommendation would provide a greater and broader public health improvement (than the existing vigorous guidelines) since its clinical benefits were greater than previously realised, and it would, in any event, enjoy greater long-term adherence (particularly among the poor and sedentary) because it was physically easier to do and sustain. **(personal communication with SN Blair, London 2004, 2006, 2007, KE Powell 2007, A Franks 2007, M Pratt 2007 and T Bazzarre 2007)**

While it is beyond the scope of this dissertation to look closely at all of the health outcomes dealt with in the Report (listed above) the treatment of activity intensity and duration will now be examined in depth concerning cardiovascular disease, and briefly in relation to all cause mortality, cancer, and type 2 diabetes (DM2 or NIDDM) and obesity. Somewhat greater attention will be given to obesity in order to explore the apparent anomaly of why well established knowledge about energy balance (between intake and activity expenditure) was given relatively short attention -- at a time when evidence of the rising incidence and prevalence of unhealthy weight gain was emerging.

9.6 Chapter 4 of the Report: Intensity v Volume in Relation to Health Protection

9.6.1 Overall (All-Cause) Mortality and Cardiovascular Disease

Before the Report turned in Chapter 4 to discuss the evidence on physical activity and cardiovascular disease, it turned briefly to the less frequently examined study of all-cause or overall mortality, which was, and is still heavily influenced by the high incidence of cardiovascular disease mortality itself. The Report tended, therefore, to blur the distinction because studies which looked at all-cause mortality (notably Blair and Paffenbarger) also examined its prime component, cardiovascular mortality, in depth as well. Its conclusion, while apparently un-contentious, was also unclear and therefore ambiguous: “The data reviewed here suggest that regular physical activity and higher cardiorespiratory fitness decrease overall mortality rates in a dose-response fashion.” **(USSG 1996 p 87)**

What exact 'dose' of physical activity did the authors have in mind? By 'regular' did they mean regular 'frequency' as the dose, without regard to intensity or duration? Was a regular stroll equal to a regular jog? Or did 'regular physical activity' only impact on mortality if, in a linear fashion, it increased cardiorespiratory fitness? The text failed to provide an answer to those questions.

The core Chapter 4 of the Report, in large measure, avoided discussing the key issue of intensity of activity, except perhaps, when it could, on rare occasions be used to bolster the 'moderate-intensity' hypothesis where, unusually, the studies (see particularly on hypertension below) appeared to show better results from moderate intensity activity than from vigorous. The Report chose, for example, to highlight one seldom cited longitudinal follow-up study on all-cause mortality, the subjects of which were exclusively male Seventh Day Adventists. **(Lindsted et al 1991)** This study reportedly "found an inverse association among the moderately active group but less of an effect in the vigorously active group." **(USSG 1996 p 87)**

9.6.1.1 Blair et al 1989

Surprisingly, Blair's seminal 1989 results on all-cause mortality **(Blair et al 1989)** were mentioned, but only to highlight the fact that studies examining fitness with some precision (as his did) tended to show stronger inverse associations with mortality (of any kind) than did studies which tried to measure the more amorphous and imprecise concept of physical activity, especially when captured by less-than-precise self-reported questionnaires. Curiously, however, there was no reference to the stunning mortality reductions he reported among the subjects in the second least fit quintile – compared to the most sedentary – even though his paper described that fitness level as achievable with a moderate intensity 'brisk walk' of as little as 30 minutes each day. **(Blair et al 1989 p 2400)**

This steep concave curvilinear outcome was again ignored in the Report when **Blair et al 1989** was cited one page later and included under discussion of "five large cohort studies relating cardiorespiratory fitness to risk of CVD mortality". Its distinctive concave curvilinear trend simply disappeared: "Each of these studies demonstrated an inverse dose-response relationship between level of cardiorespiratory fitness and CVD mortality." **(USSG 1996 p 87)** When the study was listed in Table 4-1 of the Report, its cardiovascular findings were bafflingly described as "inverse association....significant linear dose response" **(op cit p 89)**

One might tentatively surmise that Blair's finding of a steep concave curvilinear trend of such 'public health importance' was not reflected in the US Surgeon General's Report because this remarkable curve was not replicated in the 1996 extension and follow up of the Aerobic Center Longitudinal Survey (ACLS) cohort (**Blair et al 1996**) -- as was discussed in Chapter 8 . Further, Blair was unable in 2007 to recall whether he drew these later and then unpublished results, which were inverse, but linear (not curvilinear), to the attention of the authors and editors of Chapter 4 before they finished compiling the Report, even though he was, himself, the senior scientific editor of the Report. **(personal communication with SN Blair, London, October 2007)**

9.6.1.2 'Levels': Further Conflation of Intensity and Duration

Direct discussion of the importance of the intensity of energy expenditure was also deflected by the introduction of the measurement term – 'levels':

"The demonstrated dose-response relationship indicates that the benefits derived from physical activity occurs at moderate levels of physical activity or cardiorespiratory fitness and increases with increasing levels of physical activity or higher levels of fitness." (**USSG 1996 p 87**) **(emphasis added)**

Fitness is a singular and relatively precise measure of cardiorespiratory output (usually % of VO_2 max - maximal oxygen uptake) and thus can be ranked in 'levels' or degrees. But a 'dose' of physical activity can only be accurately described and defined by measuring both its intensity and duration, before considering the frequency with which that precise dose of activity is conducted. Only when these three parameters are independently measured, might a 'level' of physical activity be accurately and explicitly defined.

The term 'level' is also unhelpful in that it was seldom used in the epidemiologic literature which the Report's authors and this dissertation have surveyed. Indeed, the two defining consensus conferences that immediately preceded the Report (**CDC/ACSM Pate et al 1995 and NIH 1996**) both specifically recommended 'moderate-intensity' activity as their precise public health guideline with duration (30 minutes) and frequency (5+/wk) also specifically defined.

Nor would the use of the term 'level' appear to have been arbitrary, or accidental. For when summarising and concluding the section on cardiovascular diseases the Report again observed:

"The epidemiologic literature supports an inverse association and a dose-response gradient between physical activity level or cardiorespiratory

fitness and both CVD in general and CHD (coronary heart disease) in particular.” **(USSG 1996 op cit p 112)**

By using the term ‘physical activity level’, the Report thus conflated the three more precise measures of activity (intensity, duration and frequency). This allowed the anomalous interpretation that the ‘inverse dose-response’ in disease prevention was, for example, identical from a lower-intensity, longer-duration activity done 5 times a week - as compared with a higher-intensity, shorter-duration activity done 3 times a week. Thus 30 minutes of brisk walking 5 times a week (the Report’s preferred new public health guideline prescription) would provide exactly the same physiologic response in providing disease protection as 20 minutes of jogging 3 times a week. But as we have seen, this concept had been discredited some pages earlier in Chapter 3 of the Report. Lower ‘rates’ of work, as defined by speed or intensity of walking, produce less cardiovascular response. **(op cit p 62)**

9.6.1.3 Lee et al 1995

As discussed earlier in this chapter, the Report anomalously did not even cite, and much less discuss the most recent study **(Lee et al 1995)** co-authored by Ralph Paffenbarger. This omission appears all the more curious and surprising because Paffenbarger and Lee, in the long running Harvard Alumni Study, chose in this most recent investigation precisely to focus upon and examine the importance of the intensity of energy expenditure in reducing all-cause mortality. As was seen in Chapter 8, Figures 8.5, 8.6, and 8.7) their conclusion was clear: Vigorous activity significantly reduced mortality, whereas non-vigorous activity did not. **(Lee et al 1995 p 1181)** If Paffenbarger and Lee suspected that their Harvard cohort were fitter than a typical American population (and thus measurably responsive to low-to-moderate intensity activities) they did not report on this consideration. Further, it should be noted that the ‘vigorous only’ finding would not prove a rogue result. The finding and broadly replicated in an update of the Harvard Alumni Study five years later. **(Lee and Paffenbarger 2000 and Sesso et al 2000)**

The question therefore remains: How and why was this highly pertinent piece of research, published in a supremely reputable US medical journal, and investigated by the field’s most eminent scientists, at best overlooked, and at worst, intentionally ignored by those trusted with writing the US Government’s definitive public health report and recommendations on physical activity? The answer appears to lie in the fact that latest findings from Paffenbarger’s team seriously undermined the ‘moderate hypothesis’ which, in turn, underpinned the radical decision to downgrade the

importance of vigorous intensity activity – and to replace it with a moderate-intensity and total volume activity prescription as the new primary public health recommendation from the United States government. In their desire to promote a single and simple public health message, which they hoped would bring ‘substantial health benefits’, especially to the majority of sedentary Americans, they apparently chose to ignore important scientific evidence which undermined an unproven hypothesis that was presented as a fully ‘warranted’ scientific fact.

9.6.2 Cardiovascular Disease (Hypertension) – Intensity (Moderate) Does Matter

Having largely ignored the intensity debate – or simplified it with use of terms like ‘levels’ and ‘amount’, the Report became unusually interested in the comparative intensity of energy expenditure when it turned to examine the scientific literature on hypertension which was reviewed in the cardiovascular diseases section of Chapter 4. Did this sudden shift of focus and interest possibly occur because it had found some recent evidence to suggest, that for reasons unexplained, moderate intensity activity appeared in some cases to improve (lower) blood pressure (systolic and diastolic) more significantly than higher intensity activity? It would appear so, and the hypertension section was concluded thus:

“Three (intervention) trials have specifically examined the effect of different intensities of exercise on blood pressure.” **(Hagberg et al 1989, Matsusaki et al 1992, Marceau et al 1993). (USSG 1996 p 110)** After briefly reviewing the findings, the Report concluded, albeit tentatively, that:

“These trials provide some evidence that moderate intensity activity may achieve a similar, or an even greater blood-pressure lowering effect than vigorous-intensity activity.” They remained cautious, of course, but they were able to suggest: “Because few studies have directly addressed the intensity question, however, the research base is not strong enough to draw a firm conclusion about the role of activity intensity in lower blood pressure.” **(USSG 1996 p 110)**

The Report nonetheless held out the encouraging prospect that further research might quite possibly add further weight to the ‘moderate hypothesis’. However, the available and much broader research base on hypertension which they also reviewed provided a very different analysis and interpretation. The Report cited two recent meta-analyses which had together reviewed 22 controlled intervention trials, most of which were conducted at vigorous intensity and overall showed significant reductions in systolic

and diastolic blood pressure in both hypertensive and normal subjects. Moreover, the authors of one of the meta-analyses concluded that the key determinant was not intensity but frequency of activity: “All activities, including weight training, lowered blood pressure and daily activity produced greater blood pressure reduction than when performed [only] three times per week.” (**Arroll and Beaglehole 1992 p 439**)

Second, the Surgeon General’s Report included a table (**USSG 1996 Table 4-4 pp 108-09**) showing the results of 6 population-based cohort studies which had examined the association of physical activity and hypertension. Only 2 directly compared moderate and vigorous intensity activities and both of these studies showed better results from vigorous than moderate intensity expenditure. Paffenbarger was reported to have found a 30% reduced risk of developing hypertension among male subjects who played vigorous sports compared to those who did not. (**Paffenbarger et al 1991**) Similarly, Folsom and colleagues found among 41,000 Iowa women that those who reported ‘high levels’ of physical activity had a 30% reduced risk of developing hypertension compared to those reporting ‘low levels’, whereas those who reported ‘moderate levels’ had only a 10% reduced risk. Once again, the term ‘levels’ conflates, but it appears safe, especially in such a large cohort, to assume that those who reported ‘high levels’ took part in more higher intensity activity than those who reported less. (**Folsom et al 1990**) This information, while supplied in Table 4.4, was not discussed in the text – not even when the Report was directly addressing the issue of intensity.

Finally, of those three trials cited above that specifically examined intensity, only two favoured moderate intensity activity (and only in one measure of blood pressure), while the third showed similar results for moderate and vigorous intensity. Moreover, all three studies were short term and had very few subjects (n=33, n=26, n=11, as above respectively) all of whom were already diagnosed as being hypertensives. One must question what important public health assumptions could be drawn from such small, and symptomatic samples, and why the Report drew such attention to them.

In summary, then, the Report chose anomalously to focus on intensity of activity when, in 3 small intervention studies, some unusual, but hardly conclusive evidence emerged that moderate intensity was superior in lowering hypertension while a much greater quantity of significant evidence to the contrary was de-emphasised or discounted.

9.6.3 Cardiovascular Disease (HDL Cholesterol)

A similar example of apparent selective interpretation occurred in the Report's review of the HDL (high density lipoprotein cholesterol) literature on activity intensity. It reported that literature reviews showed that 'about half' of some 60 studies found increased HDL after 'exercise training', -- a term strongly suggesting at intensities normally considered to be more vigorous than moderate. Yet, it went on specifically to highlight one single study, Duncan et al's 1991 randomised controlled trial (see Chapter 7): "Moderate-intensity exercise was seen to increase HDL as much as more vigorous exercise in one randomized controlled trial of women." (**USSG 1996 p 111**)

But other, well designed studies which clearly showed the superiority of higher intensity and/or higher fitness (**for example: Folsom et al 1985, Blair et al 1983, Lakka et al 1992**) were not given similar highlight, or not mentioned at all.

9.6.4 Colon Cancer – Intensity Obscured Again

In 1996 cancers accounted for about 25% of all deaths in the United States. This high incidence, coupled with the public's perceived and particular fear of the diseases, may help explain why more than 12 pages of the Report were given to the assessment of the preventative, or protective impact of physical activity on 7 categories of cancer (colon, rectal, breast, other hormone-dependent cancers in women, prostate, testicular, and other site-specific cancers). However, the Report found a strong (preventative/protective) association only between physical activity and colon cancer, and only this association will be discussed here.

The conclusion on colon cancer in Chapter 4 stated, without reference to, or qualification by specific intensity, duration or frequency, simply and broadly that:

"The relative consistency of findings in epidemiologic studies indicates that physical activity is associated with a reduced risk of colon cancer, and biologically plausible mechanisms underlying this associated have been described." (**USSG 1996 p 124**)

The impression given was that all physical activity is protective. Yet simple analysis of data supplied in the Report itself, and a closer reading of data which the Report did not address, showed again that the issue of intensity was, anomalously overlooked, ignored, dismissed or not adequately considered.

First, In discussion of likely biologic mechanisms for protecting against colon cancer (only paragraphs before the general, unqualified conclusion above) the Report specifically cited sources which concluded that intensity of the activity was apparently

an important factor in colon cancer protection because of its favourable impact on faster intestinal motility:

“Strenuous physical activity increases prostaglandin F2 alpha, which strongly increases intestinal motility, and may suppress prostaglandin E2, which reduces intestinal motility and, released in greater quantities by colon tumor cells than normal, accelerates the rate of colon cell proliferation.” **(op cit p 124)**

Second, the Report again included important outcome data from relevant studies in tabular form **(op cit table 4-5 pp 114-15)**, yet anomalously failed to comment upon it in the text. For example, among the 11 studies listed, at least three specifically tested for, and found, a strong protective effect of ‘vigorous’ or ‘strenuous’ intensity activity on colon cancer **(Giovannucci et al 1995, Longnecker et al 1995 and Slattery et al 1988)**. No attempt was made in the text of the Report to consider whether higher intensity activities were essential, or at least conferred greater protective effect, than those of moderate intensity.

Of even more concern than omission, perhaps, was the apparent distortion of the data that was supplied in table 4-5 from both the Giovannucci and Slattery studies – which implied that intensity was not an important element of the ‘activity doses’ that they tested. For example, the large questionnaire study by Giovannucci and colleagues of 47,000+ male health professionals was described in the table as using a “weekly recreational physical activity index based on 8 categories of moderate and vigorous activities.” **(USSG 1996 p 116 table 4-5)** This may have suggested an even mix of intensities and/or a failure of the study’s authors to be precise in measuring exercise dose. Closer inspection of the study, which was supervised by Walter Willett at Harvard University’s School of Public Health, reveals very close attention to the activities recorded:

“Participants reported the average time per week spent doing each of eight moderate and vigorous activities, choosing from among 10 possible responses that ranged from 0 minutes to 11 or more hours per week. The specific activities listed were walking or hiking outdoors (including walking during golf); jogging (slower than 10 minutes/mile); running (10 minutes/mile or faster); bicycling (including that done on a stationary machine); lap swimming; tennis, squash, or racquetball; and callisthenics or rowing. In addition, each respondent reported the number of flights of stairs he climbed daily and his usual walking pace.” **(Giovannucci et al 1995 p 328)**

With the probable exception of much of the walking and some bicycling and stair climbing, all of these activities were characteristically classed as vigorous: ≥ 6 METs (**Ainsworth et al 1993, and 2000**) Furthermore, from the answers to the questionnaires Willett's team then assigned a weekly MET score 'activity level' to each subject, which was, unfortunately aggregated (thus conflating intensity and duration). Nevertheless, a protective effect was seen (referent to sedentary) at fairly low MET scores, suggesting that moderate amounts of moderate intensity activity did have a protective effect. However, increasingly higher scores gave increasing protection in a linear fashion, which were unlikely to have been achieved without considerable vigorous intensity activity given the intensity of most of the list of activities recorded.

"The median activity level of 11.3 MET-hours/week for the cohort was low, approximately equivalent to 1 hour of running, 2 hours of tennis, or 3 hours of walking at a moderate pace. The median level is an underestimation because we assessed only eight common activities, but our results suggest that relatively modest levels of physical activity may substantially reduce the risk for colon cancer. However, up to at least 46.8 MET-hours/week (the 90th percentile), the higher the activity level, the lower the risk for colon cancer." (**Giovannucci et al 1995 p 333**)

9.6.5 Type 2 Diabetes DM2 (NIDDM non-insulin dependent diabetes mellitus)

A failure adequately to discuss and recognise activity intensity occurred again in the smaller section on Type 2 Diabetes. Paffenbarger used his now familiar 'physical activity index' when he looked at DM2 incidence among his Harvard Alumni population (**Helmrich et al 1991**) The US Surgeon General's Report did make one brief and passing reference to the study's finding for the superiority of higher intensity activity: "This study showed a more pronounced benefit from vigorous sports than from stair climbing or walking." (**USSG 1996 p 126**) But it made no further comment. Nor did it draw attention to the fact that all three studies that it chose to include (**table 4-8 op cit p 127**) specifically reported the beneficial effect of 'vigorous sports or activity' on DM2 protection.

In discussion of 'biologic plausibility' the primary mechanism also appears to have been the effect of higher intensity activity: "In general, studies of exercise training have suggested physical activity helps prevent NIDDM by increasing sensitivity to insulin." And: "Insulin sensitivity and rate of glucose disposal are related to cardiorespiratory fitness even in older persons." (**op cit p 128**)

And yet, in the conclusion no mention of the importance of exercise intensity or cardiorespiratory fitness was made. Instead, a broad and imprecise recommendation was made that: “The epidemiologic literature strongly supports a protective effect of physical activity on the likelihood of developing NIDDM in the populations studied.” (**op cit pp 128-29**)

9.6.6 Obesity: Selective Interpretation and Omission of Evidence

Given the considerable and historic physiologic understanding of the benefits of long term balance between energy expenditure and energy intake, it may, at least from an early 21st century perspective, be difficult to comprehend why the *US Surgeon General's Report on Physical Activity and Health 1996* devoted just two pages to unhealthy weight gain and obesity. Indeed, the Report's opening remarks can only be judged as dismissive in assessment of the scientific role of physical activity (energy expenditure) in preventing unhealthy weight gain:

“It is commonly believed that physically active people are less likely to gain weight over the course of their lives and are thus more likely to have a lower prevalence of obesity than inactive people; accordingly, it is also commonly believed that lower levels of physical activity are a cause of obesity. Few data, however, exist to evaluate the truth of these suppositions.” (**USSG 1996 p 133**)

9.6.6.1 Obesity and intensity of Physical Activity

Turning again briefly to the specific issue of intensity of activity, it is surprising how the Report, either with imprecision, or by selective omission, neglected the importance of intensity of energy expenditure when discussing physiologic outcomes. It concluded simply that: “Independent of its effect on body weight and total adiposity, physical activity may favourably affect fat distribution.” (**USSG 1996 p 134**) The Report examined six studies from the United States, Canada and Europe. (**Kaye et al 1990, Slattery et al 1992, Troisi et al 1991, Wing et al 1991 Seidell et al 1991 Tremblay et al 1990**) None specifically found moderate intensity more effective, while three observed to a greater or lesser degree, that higher intensity activity was more effective in improving the waist to hip ratio than less intense activity. (**Slattery et al 1992, Troisi et al 1991, Wing et al 1991**) A European study by Seidell and colleagues (**Seidell et al 1991**) only recorded a significant effect from ‘sports activities’.

The sixth study cited provided even stronger evidence that the Report was highly selective in its mis-interpretation of the very evidence that the Report's authors

reviewed. This study (**Tremblay et al 1990**) was led by Claude Bouchard who would soon become, and remains, the director of the Pennington Biomedical Research Centre at Louisiana State University – arguably the most respected academic centre for obesity research in the United States. Most of the other studies cited above were multi-factorial and had several determinants: physical activity was only one of several aspects investigated of behaviour or the environment (others most commonly included diet and smoking) that might affect body fat distribution. Not only did Bouchard and his team look exclusively at physical activity but they looked specifically at and entitled their study: *Effect of Intensity of Physical Activity on Body Fatness and Fat Distribution*.

Subjects were more than 26,000 men and women who had answered the 1981 Canada Fitness Survey and were subsequently measured by subcutaneous skinfold instruments and for waist and hip circumference. Both sexes were categorised into four subgroups judged by the intensity of the leisure time activities. The authors concluded:

“In general, subjects practicing vigorous activities on a regular basis had lower subcutaneous skinfold thicknesses and waist-to-hip ratios (WHRs) than those not performing these activities.” (**op cit p 153**).

They went even further in rejecting the ‘total volume’ hypothesis of the Report and the ‘moderate modernisers’ led by Blair and his group: Bouchard and colleagues observed:

“These differences remained statistically significant after a covariance analysis was used to remove the effect of total energy expenditure of leisure time activities on subcutaneous fat and fat distribution....This result suggests that high-intensity exercise is associated with a preferential mobilization of abdominal fat.” (**op cit p 153 and 157**)

9.6.6.2 Summary of Obesity Evaluation

The US Surgeon General’s Report on Physical Activity and Health could have been criticised for failing, despite emerging evidence from the CDC, to address rapidly and fully enough the growing incidence and prevalence of obesity in the United States – caused in large part by the sedentary lifestyles of Americans about which the Report’s authors were acutely aware.

In the limited space allocated, the Report failed adequately to distinguish and appreciate the strong protective role that physical activity had been shown to play in preventing unhealthy weight gain from its less convincing role in successfully sustaining long term weight loss among people already obese. It undervalued,

misinterpreted or omitted review of considerable evidence from important observational and intervention studies that physical activity does play an important role in preventing unhealthy weight gain throughout life.

Finally, and most disconcertingly, the Report inexplicably ignored or omitted examination of the importance of intensity of activity – when the evidence (both that which it reviewed and that which it failed to cite) clearly showed, from most studies, that vigorous or intensive activity was superior to moderate intensity activity as a public health tool to protect against unhealthy weight gain, abdominal fat, and morbid obesity.

9.6.7 'Dose'

From its opening pages the US Surgeon General's Report proclaimed the arrival of an 'emerging consensus' of scientific evidence and opinion that allowed it ('warranted scientific authority') to recommend moderate amounts of moderate-intensity activity as the best public health guideline advice for the American people. However, after 145 pages, and having addressed all the major health outcomes, the Report finally focused on the problem of what it described as the 'dose' of physical activity that ought to be given in a public health 'prescription'. This might be construed as odd and late placement of such an important issue, which surely could not ignore the question of intensity within that 'dose'

The Report explicitly recognised that physical activity needed to be described by its various 'dimensions': mode, intensity, duration, and frequency (**USSG 1996 p 147**). However, it found itself with a dilemma of its own making: The Report had committed itself, as we have seen, with little visible evidence, to the notion that it was scientifically and physiological unimportant how two functions were mixed – intensity and duration could be inter-changed. Thus no examination of the importance of varying intensities of activity to effect specific health outcomes was necessary (except on the rare occasion when moderate intensity could be construed as superior). Again the Report repeated the central claim of the 'moderate hypothesis' that the important measure was simply the total volume (kcal of expenditure) or the 'amount' of physical activity:

“Since amount of activity is a function of intensity, frequency and duration, increasing the amount of activity can be accomplished by increasing any, or all, of those dimensions.” (**op cit 147**)

Furthermore, the Report argued that such scientific scrutiny was ‘problematic’ because the epidemiologic studies in the field had not been ‘standardized’ – a euphemism, perhaps for scientific methods, design and interpretation that lacked rigour and precision.

“Using the epidemiologic literature to derive recommendations for how much and what kind of physical activity a person should obtain is problematic, in part because the methods for measuring and classifying physical activity in epidemiologic studies are not standardized.” **(op cit 146)**

The literature, the Report argued, could therefore only be relied upon to show a causal trend between an increasing total volume of activity and increasing health benefits – anything more precise was unfortunately just not possible – unless, of course, moderate intensity activity could be construed to be equal, if not superior to vigorous intensity:

“Such studies are less helpful, however, in assessing the relationship of health benefits to intensity of physical activity (i.e., how hard one must work during the activity itself) because few studies have separately measured or analyzed levels of intensity while taking into account the other dimensions of activity (e.g., frequency, duration, total caloric expenditure). As described earlier, however, for some health benefits (e.g. blood pressure lowering) clinical trials of exercise intensity suggest similar if not greater benefits from moderate as from vigorous-intensity exercise.” **(op cit p 146)**

We have already seen earlier in this chapter that the clinical trials referred to were very small, of short duration, included only hypertensives and, were, to some degree, inconclusive. In summary, the Report’s arguments appear to have been variously: Volume is the only important factor, and besides, the literature is too imprecise for more exact scrutiny....unless the data happens to suggest that moderate intensity activity provides a superior health outcome.

This pattern of selective interpretation continued when the Report chose to highlight studies **(Leon et al 1987 and Slattery et al 1989)** where small volumes kcal/amounts of moderate intensity activity showed unusually significant reduction in CHD mortality, allowing them to conclude from their interpretation of the literature that:

“Based on these studies, it is reasonable to conclude that activity leading to an increase in daily expenditure of approximately 150 kilocalories/day (equivalent to about 1,000 kilocalories/week) is associated with substantial

health benefits and that the activity does not need to be vigorous to achieve benefit.” **(USSG 1996 p 147)**

There was, the Report suggested, nothing wrong with vigorous intensity activity – but it was represented as not necessary – volume with sustained adherence was the new public health message:

“For some people, a vigorous workout at a health club is the most sustainable choice; for others, activities integrated into daily life (e.g. walking to work, gardening and household chores, walking after dinner) may be a more sustainable option. Periodic re-evaluation may be necessary to meet changing needs across the life span.” **(op cit p 147)**

Having concluded that intensity and duration were essentially equal and interchangeable components of physical activity, the Report then anomalously contradicted itself by choosing, as the first ‘research need’ to distinguish and determine the value of these components after all. That research should:

“Delineate the most important features or combination of features of physical activity (total amount, intensity, duration, frequency, pattern or type) to confer specific health benefits.” **(op cit p 150).**

9.7 Chapters 5 and 6 of the Report : Adherence: Activity Trends, and Behavior

The final two chapters of the Surgeon General’s Report, Activity Trends, and Behavior attempted to identify then current population trends for, and adherence to, leisure time physical activity in the United States.

9.7.1 Activity Trends

As was reported in an earlier chapters, despite repeated and unreferenced claims by the Blair group and other investigators that Americans – and especially the sedentary majority – eschewed vigorous activity but would welcome, take-up, and adhere to a ‘moderate activity health prescription’, the US Government’s own survey results, used in the Report showed no such conclusive evidence.

These indicated that about 22 percent of adult Americans claimed to do ‘regular sustained leisure time activity’ each week (defined as 5+ times/wk at any intensity). This compared with 15 percent who claimed to do regular vigorous leisure time activity at least 3 times a week. **(USSG 1996 p 200)** Even those raw figures suggested that the gap between the number of ‘moderate’ and ‘vigorous’ exercisers was, perhaps

surprisingly, small. Moreover, the gap was not widening and it cannot, in any event, be assumed that all 22 percent claiming 'regular sustained leisure time activity' were exercising at a moderate intensity. Some, at least, will have been performing light activities much of the time – and, of course, some, perhaps a small proportion, of very keen Americans will have been exercising vigorously 5+ times a week. Were both of these groups to have been stripped out the real number of 'sustained moderates' would have been less than 22%.

Moreover, the Report's persistent and systematic attempts to bolster the 'moderate hypothesis' were further (and perhaps accidentally) undermined when, unusually, the merit of vigorous intensity activity was characterised thus: "People who exercise both regularly and vigorously would be expected to improve cardiovascular fitness the most." (**op cit p 181**) Note, the statement stressed not just cardiorespiratory but cardiovascular fitness – a broader and more definitive measure of heart health and protection.

Finally, a slightly deeper look into the reported demography indicated that overall, older adults (45 to 74 years) claimed to exercise more often (and relatively more vigorously) than younger people, giving their reason as having 'greater leisure time': The Report said:

"The finding of generally lower prevalences of regular, vigorous activity among younger than older adults (Table 5-5) may seem unexpected. It is explained partly by both the greater leisure time of older adults and the use of an age-related relative intensity classification" (**USSG 1996 p 184**)

It is to the important issue of perceived leisure time that we finally turn and to the last Chapter 6 of the Report on adherence strategies.

9.7.2 Adherence to Physical Activity

According to the Scientific Editor, Adele Franks, the final Chapter 6: "Understanding and Promoting Physical Activity" – was easily the least rigorous and successful of the Report. It contained no serious attempt to examine, by behavioural theory or any other scientific method, whether the plausible claim that moderate-amount-intensity leisure time activity recommendation would attract greater population adherence than the previous vigorous-intensity guideline. (**personal communication with A Franks, Northampton Massachusetts, May 2007**) Instead, the chapter was largely taken up with theories and models used in social science research about personal motivation

(for example 'self-efficacy') and descriptions of various interventions previously attempted in community and worksite programmes.

Most importantly, even confronted with recent and persuasive adverse evidence (**King et al 1995**) the Report failed to examine the rather obvious fact that its recommendation for the new moderate activity guideline would require individuals to exercise 5, and preferably all days of the week (compared to just 3 times a week for the previous vigorous guidelines) and for a total elapsed time which was more than twice longer (2 ½ hr – 1 hr) per week than the vigorous guidelines. Indeed, when considering why the moderate-intensity lifestyle group in the King and Haskell study scored far worse on adherence than their vigorous intensity subjects, the Report appeared to forecast the damaging flaw in its own advice, without a word of comment or explanation:

“Researchers hypothesize that it was more difficult for the moderate group to schedule 5 days of weekly physical activity than for the vigorous group to schedule 3 days.” (**USSG 1996 p 226**)

9.8 The Report: Summary and Conclusion

Production of the US Surgeon General's Report put physical activity for the first time into the front rank of US public health, along side efforts to lower blood pressure, improve cholesterol profiles and to reduce smoking incidence and prevalence. However, the Report's conclusions were flawed and distorted not only by an incomplete scientific evidence base, but by selective and anomalous interpretation of that data, which arose from several interwoven aspects of its social construction.

While entitled a report on physical activity and health, the Report focused primarily on just two diseases, cardiovascular disease and cancer. Focus on CVD was explicit and understandable given the prevalence and mortality from heart disease and the strong literature base demonstrating the protective effect of physical activity. But preponderant focus was also drawn by the success of Steven Blair and his group in 'enrolling and translating' themselves into influential roles within the American Heart Association which had its own reasons for taking a high profile and influential role in the physical activity debate.

The Report, on several occasions, openly acknowledged its intellectual debt to, and agreement with, the recent findings and recommendations of two highly influential panels CDC/ACSM (**Pate et al 1995**) and **NIH 1996** which considered physical activity and cardiovascular disease. As we have seen, these panels too were heavily

influenced by Blair and his group and their conviction that evidence for their moderate (volume and intensity) hypothesis had falsified the pre-existing vigorous activity recommendations. It is perhaps not surprisingly, therefore, that Steven Blair was chosen to become the Senior Scientific Editor of the Report, working alongside Adele Franks, a staff CDC physician. Blair himself acknowledged that, given his existing and prominent physical activity roles with the American Heart Association and the National Institutes of Health – his selection as the Senior Scientific Editor of the Surgeon General's Report was not surprising. **(personal communication SN Blair, London, October 2007)**

While the primary pressure to devise and implement the new moderate activity 'paradigm' as US public health policy came from the 'internal' influence of Steven Blair and his group, it was clear to Adele Franks that the 'moderate message' was precisely what the politicians and policymakers – principally the Secretary of Health and Human Services (Donna Shalala) and the acting Surgeon General (Audrey Manley) – wanted, in policy terms, to embrace. It is Franks view that both women wanted to accept the notion that the American people suffered from a 'misperception' that only vigorous activity, which deterred them, brought health benefits, whereas the American people would happily adopt and adhere to moderate activities, if only the 'surprising' benefits were explained to them. Franks said:

“That was clearly how this report was sold to the Surgeon General in the first place -- to have her say yes, when they said to her there is a misperception out there and you want to show that there are other kinds of physical activity that the population are more likely to adhere that had health benefits. That's what caught her attention....the misperception that you had to go out there and sweat hard and do vigorous physical activity...but in fact you could take walks, and not sweat and that there was documented health benefits. And that's what persuaded her that this should be worked up into a Surgeon General's Report.” **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Furthermore, Franks said she felt intense (political) pressure from Shalala to complete the Report, no matter how flawed, before the opening of the 1996 Olympic Games in Atlanta:

“The secretary of DHHS [Shalala] wanted the report out before the Olympics and we were already behind schedule and my job was to get this report out on time or heads were going to roll. They needed somebody who

could step in, who could be objective, diplomatic and who could turn this thing around very fast. I said, 'I don't think it's possible to do it this fast'. I also asked almost every division in the Center [CDC] to donate some scientists to help review the papers. Because, after I got into it and started pulling the references, I thought, oh my God, what they are saying isn't even true, based on the references. It was such an exaggeration of the data, so I had every paper reviewed by scientists, to give me a report back on what did this paper really say, and is this a correct statement, or not. I wanted to make sure that each citation was correct for what it was being cited for." **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Moreover, Franks said the 'exaggeration of the data' came persistently from an apparent desire to press the 'moderate message':

"Yes, it was exaggerating the findings in terms of the clarity and certainty of moderate physical activity's health benefits.....It wasn't random error, it was clearly exaggerating the benefits of moderate activity." **(personal communication with Adele Franks, Northampton, Massachusetts, May 2007)**

Despite Franks' late interventions, the temptation, selectively to interpret the scientific evidence for each considered health outcome was not always identified and resisted. From its opening political preamble, through its main focus on heart and other disease outcomes, and then on to its final chapters on activity trends and adherence behaviour, the Report systematically played down and misinterpreted the clinical and behavioural record of vigorous activity – while maintaining variously that: total volume of energy expenditure (not intensity) was the key health factor and/or that activities of a moderate 'amount/level/intensity' were as good, and sometimes even better in improving health outcomes.

Such 'selective interpretation' was further revealed by the internal contradiction seen in Chapter 3 of the Report when physiologic responses were examined. Here the 'rate' of activity (intensity) was discussed and "lower rates of work" were said to "place relatively small demands on cardiovascular and respiratory systems..."(**USSG 1996 p 62**), an apparent refutation of the 'moderate/total volume' message that ran throughout the Report.

Further, the Report claimed – in spite of contemporary evidence and comment to the contrary (**Winett RA 1995, Lee et al 1995, Haapanen et al 1996**) that an 'emerging

consensus' on the surprising benefits of moderate activity had been achieved, and this would, when properly promulgated, lead to a big upsurge in adherence – especially from the majority of sedentary Americans.

The Report failed even to discuss Paffenbarger and Lee's then most recent study (**Lee et al 1995**) showing no significant reduction in all cause mortality no matter how great the volume of non-vigorous activity undertaken. And the Report briefly described, but then failed adequately to address, the disquieting evidence (**King et al 1995**) that its preferred public health prescription (5+/wk 30 min brisk walk) would fail because it demanded too many weekly days of adherence among a population which considered itself seriously 'lacking in time'.

The explanation for the fundamental anomalies and inconsistencies in the Report stem directly from the desire of both politicians and policy makers to promulgate a new public health prescription for physical activity which they believed would be more widely accepted, and acted upon, especially by the evidently growing number of sedentary Americans. Steven Blair and his close colleagues, as Ancel Keys had done before them, no doubt acted primarily with the public health in mind when they sought to turn their unproven hypothesis into the 'warranted authority' of proven and verified scientific fact that had come from 'an emerging consensus' of investigators. This social construction of the scientific evidence came, unusually, not from macro-economic economic forces, but internally from within the American academic, scientific and public health communities themselves.

It is to a final examination and analysis of the anomalies of both selection, and interpretation of all the scientific and policy literature, which has already been reviewed chronologically, that we now turn.

Chapter 10: Analysis of Anomalies

10 Introduction

Previous chapters have chronologically examined the primary scientific studies and policy papers on physical activity and health between 1953 and 1996. This final chapter's task is different. It sets out, using the techniques of the political Sociology of Scientific Knowledge (pSSK) and realist Actor-Network Theory described in Chapters 2 and 3, to classify and examine how arguments were deployed, evidence was interpreted, and influence was used to shape the outcome of the 1996 *US Surgeon General's Report on Physical Activity and Health*. In so doing, it intends to reveal and examine the social framing assumptions and processes by which these 'scientific' judgements were reached. The analysis further relies (see below) on the 'theoretical framework' of social influences drawn primarily from previous authors of case studies, which was elaborated in Chapter 2.

Public health physical activity guidelines in the United States underwent a substantial upheaval and transformation in the dozen years between 1984 and 1996 when the first US Surgeon General's report on physical activity and health was published. They entered this period as unofficial, and relatively unimportant recommendations, little known or implemented. They emerged, after prominent news coverage and debate, as official public health guidelines of the US Government and touted as a primary tool in the prevention of cardiovascular, and to a lesser extent, other morbidities and fatal diseases, including cancer, type 2 diabetes, unhealthy weight gain and morbid obesity.

The guidelines' emergence coincided with growing awareness that Americans had become increasingly sedentary with the rapid evolution from manual labour to 'white-collar' office working, and with domestic lifestyles built around ever more plentiful and affordable 'energy saving' devices and energy dense 'fast food'. Since the first epidemiological work of JN Morris in Britain (**Morris et al 1953**) and then from evidence from the US Government funded *Framingham Heart Study*, it had become increasingly clear that physical inactivity – even in the absence of unhealthy weight gain – was, in population terms, a serious independent risk factor for the cardiovascular diseases on a par with cigarette smoking, adverse cholesterol levels, and high blood pressure. (**Kannel WB 1967**)

Apart from, and prior to the emerging epidemiological studies of Morris and later investigators, the primary investigation of human physical activity had been undertaken by exercise physiologists – a discipline primarily concerned with understanding and developing the performance of elite athletes. **(Pate et al 1995 p 404)** That evidence showed a strong association between increasingly vigorous intensity activity, cardiorespiratory fitness and improved sports performance. Similarly, the large epidemiological studies by Morris – and to a large extent subsequently by Paffenbarger in the United States – also showed an association between intensity of occupational and leisure activity and a significant reduction in heart disease – at least among their white male cohorts in Britain and the United States.

Yet within just 12 years (1984-1996) the apparent validity of the ‘vigorous (threshold) intensity hypothesis’ was overturned by a new – and entirely less demanding ‘moderate intensity (volume) hypothesis’ which its advocates were bold enough to describe as a new “physical activity-health paradigm”. **(op cit p 405)** How then, did this sudden transformation take place? It has been argued that it occurred because the public health policy decisions taken by the US Surgeon General’s Report were based not on the available scientific evidence alone, but were influenced substantially by a wide range of social factors.

The matrix below **(Table 10.1)**, drawn from the theoretical framework already explained above and categorised in Chapter 2, provides illustrative examples from this case study to demonstrate the range of ways in which the evidence and the broader public health debate about physical activity and health appear to have been socially influenced, and therefore, unscientifically treated. Each of the three main categories of influence (in **bold**) has three sub-categories (underlined).

Table 10.1

Theoretical Frame Work of Social Influences Drawn from Previous Authors

External Anomalous Influence	The 'Authority of Science' (mis) use and impact	Implicit (Explicit) Cultural Conditioning
<p><u>1. Disproportionate reliance on external experts</u></p> <p>Through K Powell and C Caspersen at CDC, the NIH and USSG office relied disproportionately upon S Blair and R Pate to set guidelines policy.</p>	<p><u>1. To bolster policy decisions</u></p> <p>Sec State Health Shalala grasps 'moderate volume hypothesis' as American scientific breakthrough and thus grounds for Surgeon General's report on physical activity. Relies on Pate et al 1995 and NIH 1996, as 'authorities'. These 'authorities' heavily influenced by Blair and his group.</p>	<p><u>1. Deep cultural allegiances/alliances</u></p> <p>Powell's small CDC division (BEEB) developed allegiance with Blair, Paffenbarger and Haskell to create the 'school of moderate modernisers' questioning the 'vigorous threshold' orthodoxy.</p>
<p><u>2. 'Enrol and translate'</u></p> <p>Blair and colleagues gained access to, and senior positions within the AHA's workshops and conferences on physical activity and through them 'warranted authority' to enter NIH, NHLBI and USSG.</p>	<p><u>2. Conflicting schools of scientific thought</u></p> <p>US 'moderate volume hypothesis' rapidly displaces the conflicting 'vigorous threshold hypothesis' of UK's Morris and colleagues, despite substantial evidence, not least from Paffenbarger's Harvard investigations, that (threshold) intensity essential for risk reduction from heart disease and all-cause mortality.</p>	<p><u>2. Exclusion of outsiders/dissenters</u></p> <p>Morris seldom cited, challenged or invited despite his groundbreaking work and high reputation. Rare exception was his place on CDC/ACSM consensus panel (Pate et al 1995) where he 'reluctantly and under duress' signed up to 'moderate volume hypothesis'.</p>
<p><u>3. Direct (external) pressure – (lobbies)</u></p> <p>AHA succeeds in getting its representative (T Bazzarre) on to planning board of USSG 1996</p>	<p><u>3. Reciprocal impact of social factors upon scientific evaluation</u></p> <p>Blair and other exercise physiologists rapidly exposed to media attention and public (health) limelight after previous, more narrow world of exercise science focused academically on physiology and sporting excellence.</p>	<p><u>3. Selective omission, inclusion or interpretation of evidence</u></p> <p>US Surgeon General's report omits any examination of Paffenbarger and colleagues' latest and highly relevant examination of 'intensity' (Lee et 1995) even though the authors themselves selectively interpreted their own data in favour of moderate activity.</p>

The social forces described in this matrix created the 'climate and conditions' that enabled the repeated selective omission, inclusion and/or interpretation of the prevailing scientific evidence on physical activity and health. With the theoretical framework's 9 'cells' of social influence as a conceptual guide, let us now examine, in specific and practical terms, the 9 areas of conflict (4), uncertainty and ambiguity (3) and finally, anomaly (2) that emerged from this case study, and which appear to have characterised the entire physical activity and health debate, and the US Surgeon General's Report itself. It should be noted, that while the theoretical 'matrix' happens to be divided and fall into 9 categories -- as do the areas of conflict, uncertainty and ambiguity specific to this case study -- this is but a numerical co-incidence, and, in any event, a somewhat arbitrary one. (See further and final discussion in Chapter 11). The 'matrix' therefore, informs but does not entirely define the discussion and analysis below.

The 9 Areas of 'Conflict', 'Uncertainty and Ambiguity' and 'Anomaly'

This policy transformation was also built on two separate, but interlocking assumptions which were portrayed as being based on substantial scientific evidence: That the key aspect or 'dose' of physical activity in terms of health protection and disease prevention was the 'total volume' (kcal) of energy expenditure (EE) and not, as previously held, the intensity of the activity. Secondly, that from a public health perspective, the US population (and particularly members of the large, and growing sedentary sub-section) would be more successful in long term adherence to moderate than to vigorous intensity physical activities. These 'interlocking assumptions' can also be characterised and described within 9 separate areas of intellectual 'conflict'(4), 'uncertainty and ambiguity'(3), and 'anomaly(2)'. They are described briefly below, before being subjected to closer scrutiny in the text that follows.

The 4 Areas of 'Conflict'

The advocates of this 'moderate activity hypothesis' chose four distinct areas of 'conflict' to try to demonstrate the validity of these interlocking propositions: 1. To demonstrate that the evidence supporting the superior health benefits of vigorous activity (and/or the existence of a minimum 'threshold intensity') was flawed or had been exaggerated. 2. To assert that vigorous activity recommendations were effectively harmful in deterring (especially sedentary) Americans from adherence to any physical activity. 3. To demonstrate that adherence to moderate intensity recommendations

would be substantially higher. 4. To claim that this alleged ‘deterrence’ (by existing vigorous guidelines) was all the more damaging because the health protection/disease prevention benefits of moderate intensity activity had been both under-valued and insufficiently investigated. The truth of each of these claimed scientific judgements will be analysed and re-examined in this chapter to ‘unpack’, how these ‘scientific assessments’ were actually constructed with ‘social’ framing assumptions, not least: how data and evidence interpretations were considered, rejected, discounted or ignored. The results should reveal the answer to the first and primary research questions of this dissertation which, to re-state them, are:

1. Why were public US public health guidelines for physical activity switched from a focus upon vigorous intensity to moderate intensity, and was the science base sufficiently sound and uncontested to justify the switch on scientific (and social scientific) grounds alone?
2. If social forces played a role, were these ‘external’, or were they largely ‘internal’ – among the scientists and policy makers themselves – or might they have been a combination of both?

The Three Areas of ‘Uncertainty’ and ‘Ambiguity’

In addition to the four areas of ‘conflict’ above, there appear to be at least three separate issues of ‘uncertainty’ or ‘ambiguity’ which may, upon re-examination, also further illuminate the answer to the principal research question:

1. To examine discrepancies between investigators over definition of the ‘brisk walk’ as first defined by Morris.
2. To explore whether cohort selection distorted comparisons and confused interpretations?
3. To ask whether ‘loose’ or ‘vague’ terms in measuring physical activity also have distorted comparisons and confused interpretation of data and evidence?

The Two Areas of ‘Anomaly’

Finally, and in relation to the two secondary research questions, there appear to be at least two aspects of ‘anomalous’ influence which bear upon the two secondary research questions (again re-stated):

1. Why were the guidelines so focused on cardiovascular disease (CVD) to the relative exclusion of other health outcomes? Once again, was this focus derived from entirely scientific grounds, or were social elements at play? 2. And were these social elements ‘external’ – for example, perhaps deriving from the American Heart Association, and US public health policy makers – or were they ‘internal’ among a smaller group of scientists and policy makers focused primarily on physical activity and health – and/or a mixture of both?

3. Did a small, influential group of investigators play a disproportionate (anomalous) role in shaping the 1996 *US Surgeon General’s Report on Physical Activity and Health* (USSG 1996)? If so, were they primarily driven by ‘external’ macro-economic or political forces or, more evidently, by ‘internal’ factors such as a desire to promote both reputations and the public health?

The terms ‘internal’ and ‘external’ (as previously defined in Chapters 2 and 3) are intended to differentiate influence on the scientific debate which springs internally from disputes and differences of interpretation within the scientific and policymaking communities, and those which may arise ‘externally’ – often, but not exclusively from macro-economic forces which stand to gain financially from influencing the outcome of policy decisions within the broad ambit of Regulatory Science.

The aspects of apparent ‘anomalous, influence’ that will be examined are:

1. Did the unique role of the American Heart Association influence the drive to shift emphasis strongly from vigorous to moderate intensity activities and also lead to undue focus on heart disease in the US Surgeon General’s 1996 Report, to the relative exclusion of other health outcomes?
2. Did Steven Blair lead a small and cohesive group of investigators in gaining exceptional access and influence within the important conferences and workshops that shaped and promulgated public health policy on physical activity? Were they primarily motivated by a genuine desire to ensure physical activity played a more prominent role in US public health policy, but also by a parallel desire to enhance their own personal and academic reputations?

Before examining these nine areas of conflict, uncertainty, ambiguity and anomaly, it should be useful briefly to review how the post-war physical activity debate fell within some of the key theoretical considerations (discussed in Chapter 2) set out by Popper,

Merton, Kuhn and the Realist Constructivists, not least concerning their concept of 'Regulatory Science'.

10.1 Theoretical Considerations Re-applied

10.1.1 Falsification of Morris' 'Vigorous Threshold' Hypothesis

As defined by Popper (**Popper K 2002 pp 58-73**) an influential group of scientific investigators in the United States attempted to 'falsify' the prevailing 'vigorous threshold hypothesis' as set out by Morris (**Morris et al 1973**), and then to replace it with a new 'moderate intensity volume hypothesis' that they believed better fitted new and emerging data, primarily from their own investigations. Their attempt began, firstly, by estimating the measurable health benefits of activities conducted below an empirical intensity measure of energy expenditure (a threshold) – and then by arguing that the measurable health benefits of vigorous intensity (or high fitness) above that threshold were not significantly greater than those produced by moderate intensity activities - or, alternatively, by the attainment and maintenance of a very modest level of fitness. These investigators collectively became what might be described as the 'moderate modernisers'.

10.1.2 'Social' Elements to the Guidelines' Construction

There were elements of the guidelines' construction that were not solely and soundly based on the available scientific evidence. The 'moderate modernisers' were motivated not merely by their academic interest in, and application of, the health benefits of exercise physiology. Their findings and interpretations were also influenced by their desire to see 'under valued' physical activity play what they saw as its important, rightful and long overdue roles as a health-protecting/disease-prevention public health tool to improve the nation's health.

Further, and to what extent, as described by Merton, were the 'moderate modernisers' motivated not only by their desire to improve the public health, but also by a desire to enhance the 'fame' of their discipline, their institutions, and their own personal reputations?

“Just as the motives of scientists may range from a passionate desire in the furtherance of knowledge to a profound interest in achieving fame and just as the functions of scientific research may vary from providing prestige-

laden rationalisations of the existing order to enlarging our control of nature, so may other social effects be considered pernicious to society or result in the modification of the scientific ethos itself. **(Merton, RK 1942 p 263)**

10.1.3 A New 'Paradigm'

The 'moderate modernisers' also came to believe, in Kuhn's parlance, that they had developed a new 'physical activity-health paradigm' **(Pate et al 1995 p 405)** based upon moderate intensity activities that would change the entire study, understanding and utility of physical activity as a public health and disease prevention concept and strategy. With hindsight, their suggestions that they were on the brink of a 'scientific revolution' of 'paradigm' dimensions, as described by Kuhn **(Kuhn TS 1962)**, may now seem a rhetorical flourish whose main purpose may have been to elevate their 'moderate intensity (volume) hypothesis' within the public health bureaucracy, and to enhance its media profile. Nevertheless, their certain aim was to replace emphasis upon the old 'vigorous intensity' public health recommendation with their own 'moderate' version.

From a Realist Constructivist perspective (including a realist approach to Actor-Network Theory) it appears clear that the 'public health motivation' argued by a relatively small, but closely knit group of largely American investigators and policy makers substantially influenced both the search for, and interpretation of, the available evidence that moderate intensity physical activity was: 1. From a behavioural (adherence) stance superior to vigorous intensity advice and: 2. From an aggregate public health perspective, moderate intensity physical activity was, surprisingly, similar in health benefits to the old, and now 'refuted' vigorous intensity recommendation.

10.1.4 Regulatory Science

Previous chapters have, in a chronological thematic fashion, examined both the academic/scientific literature and the workshops, conference and position/policy papers which led up to, and strongly influenced the *US Surgeon General's Report on Physical Activity and Health 1996*. As was said in the introduction, this chapter serves a different purpose: To identify the main areas of apparent scientific debate: examining the conflicts, uncertainties, ambiguities and anomalies that arose from the earliest published work of Morris and intensified considerably in the mid-1980s when the public health importance of physical activity began more fully to emerge. Indeed, it was

argued in Chapter 2 that the public health physical activity debate should be located within the orbit of what Ravetz and others have defined as Regulatory Science where: “Decisions frequently need to be taken even though the facts are uncertain, values are in dispute, levels of trust are low, stakes are high and decisions are urgent.” **(Funtowicz and Ravetz 1993)** The US physical activity guidelines were changed (decision taken) when the facts were uncertain, values were in dispute (for example the estimation and importance of population attributable risk, and population adherence) and when stakes were high (attributable deaths from physical activity and sedentary living were apparently rising rapidly).

The urgency of decision-making in this debate arose not only from alarm at the health consequences of a sedentary, inactive nation. It was further motivated, and the deadline set by the Secretary for Health and Human Services (USHHS) Donna Shalala, when she decided that the US Surgeon General’s Report had to be published before the start of the 1996 United States hosted Olympic Games. Moreover, the event had been awarded to the city of Atlanta, Georgia, which was, and remains, the headquarters of the US Government’s primary department for public health: the Centers for Disease Control and Prevention (CDC), the lead agency charged with staffing and producing the Surgeon General’s report. **(personal communication with A Franks, Northampton, Massachusetts May 2007).**

We now turn to examine in detail the 9 areas of conflict (4), ambiguity and uncertainty (3), and anomaly (2).

10.2 The Four Core Areas of Conflict: Research Question 1

10.2.1 To demonstrate that the evidence supporting the superior health benefits of vigorous activity (and/or the existence of a minimum absolute ‘threshold intensity’) was flawed or had been exaggerated.

Morris did not propose his ‘vigorous intensity threshold’ hypothesis until publication of his first leisure time physical activity (LTPA) study in 1973 **(Morris et al 1973)** – 20 years after his first landmark occupational study of London bus drivers and conductors. **(Morris et al 1953)** In this 1953 occupational study Morris did not initially consider the concept of an intensity threshold below which physical activity was not significantly protective against heart disease. The comparatively simple design and measurement of heart attack rates between drivers and conductors (a two point comparison) did not, and could not, explore intensity of energy expenditure with any precision. In his later

necropsy study (**Morris and Crawford 1958**) he neither found nor discussed threshold intensity. To the contrary, this study indicated a linear, gradient 'dose-response' of incipient (asymptomatic) heart disease among deceased individuals categorised as having done occupational work which was simply described as 'light', 'active', and 'heavy'—again without any method to gauge precise intensity. A similar, linear, 'dose-response' was also reported in the three point occupational studies of Taylor and Keys (**Taylor et al 1962**) and of Paffenbarger (**Paffenbarger et al 1970, 1975 and 1977**).

Similarly, Morris' 1973 leisure time study gave him ample scope to find a linear 'dose-response', and his clear 'framing assumption' was that he expected to find one: "I started [with] the hypothesis on leisure time activity that it [the crucial factor] was total activity....total volume." (**personal communication with JN Morris, London April 2004**) Yet, to Morris' expressed surprise, he could find no significant reduction in heart attack deaths simply by looking at the dose of total volume (kcal) increases in leisure energy expenditure among his British civil servant cohort. Morris was emphatic and precise about this absolute threshold finding (≥ 7.5 kcal/min for ≥ 15 mins, 2x/wk) albeit less certain about the precise bio-mechanism by which this vigorous threshold of intensity (and duration) conferred heart attack protection:

"The indication of a threshold, and the absence of a gradient of apparent benefit with increasing [volume of] activity, argues that the mechanism is through the 'training' of the cardiovascular system – possibly against hypoxia. Does the stress of habitual vigorous exercise on myocardium and coronary circulation, in a population with ubiquitous atherosclerosis, stimulate collateral proliferation and/or enlargement of the main coronary arteries?" (**Morris et al 1973 p 338**)

10.2.1.1 Paffenbarger et al 1978

Paffenbarger soon followed Morris into study of leisure time activity with his equally comprehensive study of Harvard alumni (**Paffenbarger et al 1978**). Instead of finding either a linear dose-response gradient (total volume kcal) or a threshold intensity response, Paffenbarger found both when he examined his 'physical activity index' of specified activities – both vigorous and not vigorous. He concluded: "Thus at any given level of energy expenditure, the risk of heart attack tends to be lower with strenuous sports than with more casual activities." (**op cit p 171**) By 'level' Paffenbarger meant total volume (kcal) of expenditure.

How can the similar, but substantially different conclusions from these two major studies be explained? The two investigators were both physicians with epidemiological training and an intense interest in public health. They both relied on self-reported measurement to determine physical activity. Further, while they disagreed on the importance of total energy volume expenditure alone, they did both see a significant risk reduction among those who reported 'strenuous sports' activity – and to that extent both their data, and their interpretations of it, upheld, a version of the vigorous threshold hypothesis.

On balance Paffenbarger's conclusion that both total volume of energy expenditure and an intensity threshold were the key elements of heart disease protection seemed the more plausible hypothesis. Indeed, Morris went to considerable lengths in later studies **(Morris et al 1980 and 1990)** to re-test his absolute vigorous-threshold-only hypothesis – and most notably in the 1990 study of his British civil servants. There he did report 'a somewhat reduced' heart disease rate, particularly among older men (aged 55-65) who did not achieve his absolute vigorous intensity threshold, but did achieve the 'duration and pace' of 'fairly brisk walking' for more than 3 times a week. To that extent, both Morris and Paffenbarger were in agreement that both linear dose-response (by volume kcals) and an intensity threshold played a protective role in heart disease. Further, in his later work Morris also began to refer to his threshold as "moderately intense". **(Morris et al 1990 p 331 and Morris JN 1992 p 247)** In so doing, he did not reduce the independent absolute intensity threshold definition (≥ 7.5 kcal/min or ≥ 6 METs). But he was eager to stress that such an intensity of exertion was not a strenuous hurdle for elite athletes, but rather, it was achievable without extreme effort by ordinary, reasonably fit and well, middle-aged people. **(op cit pp 251-3)**

10.2.1.2 The Emerging Role of the Centers for Disease Control and Prevention in the Exercise Intensity Debate

The apparent agreement in the 1970s between Morris and Paffenbarger that 'strenuous' or 'intense' activity played a significant role in heart disease protection was being challenged by a new concept, first prominently espoused at the landmark public health and physical activity workshop convened by Kenneth Powell of the Centers for Disease Control and Prevention (CDC) in 1984 (see earlier discussion in Chapter 6). By this time Powell and Paffenbarger had become close friends and collaborators.

In their first joint paper presented at the workshop Powell and Paffenbarger took a new step to declare that they were certainly not looking for any such absolute minimum threshold of activity “below which there is no benefit and above which one reaps full reward.” **(Powell and Paffenbarger 1985 p 123)** Thus, uncertainties about the relative importance of volume of energy expenditure versus its intensity were tangential to their work. Their framing assumption appears therefore to have been that the total amount of physical activity, regardless of its intensity, was the crucial public health issue.

This theme was taken further by another influential participant, William Haskell from Stanford, an exercise physiologist with a keen interest in public health. Haskell’s biggest contribution was to make the (then still novel) observation that public health protagonists should make a clear distinction between ‘improving health’ through many kinds of physical activity and the old notion of ‘physical fitness’ through concerted aerobic exercise – normally measured by maximal oxygen uptake (VO_2 max [*literally volume of oxygen, maximum*]). “Becoming more physically fit and improving health status are interrelated, but they are not synonymous,” he said. **(Haskell et al 1985 p 203)**

In essence, these were the first clear steps – in Popperian terms – to attempt to falsify Morris’ absolute ‘vigorous threshold’ hypothesis first elucidated in 1973 as a prescription protective against heart disease – but which had, *de facto*, also been the credo of exercise physiologists for very much longer.

In this vein, Haskell began to develop (without any offered evidence or citation) the concept that virtually any activity – apparently of whatever intensity or duration – could be shown to be significantly protective against heart disease, particularly among the growing number of sedentary Americans:

“In most cases, the major differences in the incidence of coronary heart disease are between those people who do almost nothing and those who get some form of exercise (by moving their bodies around) on a regular basis.” **(op cit p 208)**

Intensity, it would seem, might be irrelevant. Any activity done fairly frequently, was beneficial. Those bold assertions seemed, in large part, to be negated by Haskell’s own data, and twice within his own paper. First, he had already conceded on the preceding page: “It appears that it may take a **longer time** for lower intensity exercise to produce results **somewhat similar** to those frequently observed with higher intensity aerobic

training.” **(op cit p 207) (emphasis added)** Second, Haskell presented data from Paffenbarger’s Harvard Alumni study which showed a clear, inverse linear association between increasing the total volume of physical activity and death rates from heart disease and all cause mortality. Neither of these assertions seemed to square easily with the idea that the major reductions in heart disease occur when people cease doing ‘almost nothing’ and begin ‘moving their bodies around’ on a regular basis.

Similarly, Siscovick’s review presented to the workshop, concluded that: “habitual vigorous physical activity is associated with a reduced overall risk of coronary heart disease (CHD) and sudden cardiac death,” But he stressed that this result might appear in part because investigation into the potential benefits of less vigorous activity (including walking) had not been sufficiently explored, and there was a real public health need for this research to be done and evaluated. **(Siscovick et al 1985 p 180, 187)** Only then could it be said that habitual physical activity at vigorous intensity was necessary to achieve reductions in heart disease or any other health outcome.

10.2.1.3 Paffenbarger et al 1986

This apparent focus on exploring the value of non-vigorous activities was seen again in the next Harvard alumni report from Paffenbarger in his often cited 1986 examination of all-cause mortality. **(Paffenbarger et al 1986)** Paffenbarger again drew attention to the increasing protective effect of the total volume of energy expended (up to 3,500 kcal a week) without attempting to analyze whether individuals with such high totals would, plausibly, also have done large, and indeed disproportionately greater amounts of vigorous intensity since (if for no other reason) racking up such large volumes of kcals at lower energy expenditure would have taken a much greater amount of time. By contrast, he took only a single sentence to report a 35% reduction in mortality risk among those alumni who played 1-2 hrs of ‘vigorous sports’ per week as compared to those who did none – a percentage fall not matched (21%) by those who walked at a moderate pace for 9 hrs/wk as compared with those who walked fewer than 3. As we have already seen, in a later study when Paffenbarger and colleagues subtracted, and thus removed vigorous intensity activities from their total volume index, non-vigorous activity alone (up to any volume) was shown to confer no significant protective effect. **(Lee et al 1995 p 1181) (further discussion below)**

10.2.1.4 Ekelund et al 1988

Attempts to 'falsify' the vigorous intensity threshold hypothesis continued. As described earlier in Chapter 7, a team led by Haskell specifically set out to test whether physical fitness, as measured by conventional treadmill testing and heart rate response, was a predictor of cardiovascular death among healthy men (**Ekelund et al 1988**). They also asked the participants to report their own regular physical activity, which was narrowly defined to them as: bouts of "strenuous exercise or hard physical labor" (**op cit p 1380**). They further observed that the men's tested fitness level 'was closely related to (their reported) physical activity'. Unfortunately, the authors did not offer any independent measure (kcal/min or METs) to indicate how they defined 'strenuous'. Nevertheless, the men in the least fit quartile were reportedly 8.5 times more likely to die from cardiovascular disease at follow up than in the most fit quartile. The authors' explanation was: "These data suggest that the myocardial oxygen supply is enhanced as a result of intense physical training." (**op cit p 1383**)

Each of those observations would therefore appear to have supported the conclusion that regular vigorous intensity physical activity ('strenuous exercise or hard physical labor') produces levels of fitness which are highly protective against death from cardiovascular disease. Further, men who were less fit were less protected, in a linear, dose-response gradient. (**op cit Fig 2 p 1383**) Thus, while their results showed a linear slope, thus apparently falsifying Morris' absolute threshold hypothesis, the results also very much supported Morris' belief that vigorous exercise played an important role in providing a protective 'training effect'.

Yet, despite their own mortality data, Haskell and his team chose to conclude their article, not with a summary of this evidence, but with an unreferenced observation that "increased platelet aggregation has been shown in normal subjects after strenuous exercise" – a condition which, they said, might induce "myocardial infarction and sudden cardiac death." They further referenced two then recent studies which reported beneficial reduced platelet aggregation among subjects doing "moderate intensity" activities such as "brisk walking or slow jogging....in contrast to the acute thrombogenic effect of exercise alluded to above." (**op cit pp 1383-4**)

The concluding observation, therefore, might thus have implied that less intense physical activity (no more strenuous than brisk walking or slow jogging) was the preferred public health prescription, after all. Yet, by the generally accepted definition set by Morris, brisk walking and slow jogging would have, in any event, been characterised as at, or above, the threshold of vigorous activities. The authors'

conclusions, and therefore their 'public health prescription' appeared at least ambiguous, if not anomalous.

10.2.1.5 The Aerobics Center Longitudinal Studies (ACLS)

By contrast, the data provided by Blair from his ACLS cohort was, and remained without doubt, the most important and compelling evidence to have challenged the vigorous intensity threshold hypothesis. **(Blair et al 1989).**

Not only did a very modest increase in fitness provide evidence of a dramatic drop in all cause mortality for both men and women (quintile 2), but the fittest individuals in the cohort (quintile 5) enjoyed relatively little further protection. What is more, Blair measured the fitness of his cohort with treadmill tests – a method commonly agreed to be more accurate than physical activity scores drawn from self-reported questionnaires used by Morris and Paffenbarger.

While Blair's cohort was overwhelmingly white, well educated and middle class, it did at least include women, and it was undoubtedly a group much more reflective of a random sample of Americans than Morris' British male civil servants, or Paffenbarger's elite male Harvard graduates.

However, at least one uncertainty and one anomaly need to be considered. Can the extreme concave curvilinear shape of the gradient, with the rapid plunge in mortality at the second quintile of fitness, be explained by the very fact that a typical American cohort of its time would indeed have been so sedentary that even a modestly better comparative fitness (2nd quintile) would produce such a marked comparative reduction in mortality? We know, for example, that Leon's cohort was, by his own description, extremely unfit, even by American standards – and his results more closely resemble Blair's gradient than any other study of its time **(Leon et al 1987)**. Blair's data might, indeed, therefore have been the best template for producing a new moderate intensity public health guideline that would best suit the growing number of very inactive Americans. But that remains uncertain.

Three further uncertainties arise. First, Haskell's male cohort **(Ekelund et al 1988)** appear most closely in study design to have resembled the men in Blair's study, but as has been shown, Haskell's gradient was firmly linear and clearly indicated the superior dose-response benefits of 'strenuous exercise' and highest fitness. Thus, to the author's knowledge, this, the only contemporary study which appears closely to

resemble both the (male) cohort design, and methodology (exercise treadmill to measure fitness) of Blair's 1989 investigation, appeared to falsify its concave curvilinear result and its conclusion that moderate fitness confers virtually the same risk reduction from mortality as does higher fitness.

This strongly 'linear' interpretation of the results of Ekelund et al 1988 - that 'highest fitness' strongly conferred greatest protection was subsequently supported by Laukkanen and colleagues when they concluded that unlike Blair et al 1989: "...Ekelund and co-workers showed a marked difference in CVD-related mortality between high and low levels of cardiorespiratory fitness...." (**Laukkanen et al 2001 p 829**) In addition, another update from the *Framingham Heart Study* was published in 1989 which analysed self-reported questionnaire data from more than 3,000 men and women. It found a clear and significant improvement in four heart disease risk factors (HDL cholesterol, lower heart rate, lower body mass index and fewer cigarettes smoked) among men who took >1 hr per week of vigorous physical activity (≥ 7.5 kcal/min) as compared to those who did not. (**Dannenberg et al 1989 p 76**)

10.2.1.6 Blair et al 1996

Blair and colleagues did extend their own study with their ACLS cohort, looking again at the influence of cardiorespiratory fitness (and other precursors) on both cardiovascular and all cause mortality in both men and women. (**Blair et al 1996**). Data from the original cohort were combined with those from new participants who joined the study and were examined between 1981 and 1989. The inclusion and exclusion criteria (with one important exception discussed below) were not substantially altered, and yet the results showed that the shape of the gradient between fitness and all-cause mortality had changed dramatically. The new results were altogether more predictable, showing a clear, inverse linear association between fitness and mortality as Blair and his colleagues clearly said toward the end of their comment section: "Our study underscores the strong, graded, and independent association of fitness with CVD and all-cause mortality." (**Blair et al 1996 p 210**). However, what was left anomalously unsaid was any comment about how or why the ground breaking concave curvilinear gradient of the 1989 report had so evidently disappeared, or at least had not been replicated. This apparent anomaly remained unresolved. It was all the more puzzling because the one 'inclusion' criteria which did change was that in the 1989 study the authors specifically excluded subjects with personal history of heart attack, hypertension, abnormal electrocardiograms, stroke or diabetes, as were individuals who failed to reach 85% of their age-predicted maximal heart rate at baseline on a

treadmill exercise test. However, in the 1996 study individuals with abnormal electrocardiograms and/or a history at baseline of myocardial infarction, stroke, hypertension, diabetes mellitus and cancer were specifically not excluded **(Blair et al 1996 p 206)**. Presumably, therefore, this later cohort would have been generally less fit and more, not less, likely to replicate a concave curvilinear gradient than a linear one – because unfit people would plausibly show the steepest positive response to even a small improvement in fitness, compared to a fitter cohort whose response would plausibly be more modest – results which were most clearly seen, for example, in Morris’ 1990 study examined earlier among older members of his cohort. **(Morris et al 1990)**

We do know that Blair’s 1996 paper, with its conflicting, linear results, is to be found in the ‘filing cabinet’ that houses all of the surviving published literature assembled for the US Surgeon General’s Report. However, we do not know whether the paper was read and debated by the Report’s senior editors. It certainly is not mentioned or cited in the Report. In October 2007 Steven Blair said he “could not recall” whether he drew the other editors’ attention to it. **(personal communication with SN Blair, London, October 2007)**

10.2.1.7 Blair et al 1992

There were also attempts (shown below) to collect data that would suggest either that Morris’ absolute intensity threshold was mistaken and/or that exercise intensity was unimportant in public health terms. Blair and Paffenbarger observed in 1992 that the intensity of energy expenditure might have no health or public health significance whatsoever.

“For the past several decades, the generally held view is that there is a minimum exercise intensity required to stimulate an improvement in physical fitness....An alternate hypothesis to a threshold level of intensity is that the response to exercise training is primarily, if not exclusively, dependent upon the total energy expended in exercise and not intensity.” **(Blair et al 1992 p 102)**. They added:

“There is an interrelationship between intensity and duration in their impact on fitness change. Low intensity activity must be sustained longer than high intensity activity to have the same effect on improvement in aerobic power. Again, the total energy expenditure of the exercise

session is likely the critical factor for fitness change.” (**op cit p 102**)
(emphasis added)

Their paper contained more than one hundred separate references, but no corroborating evidence was cited in support of this proposition, which was portrayed as an established and warranted conclusion, and not as a mere hypothesis or assumption. Yet, their assertion that intensity and duration were – in effect – interchangeable; that low intensity activity merely needed to be sustained longer to achieve ‘the same effect’, was controversial among the relevant expert community, and at odds with the standard exercise physiology texts of the period. **(Winett RA 1995 p 534-35)**

Further, the evidence of the superiority of vigorous intensity exertion in improving aerobic capacity, or respiratory fitness, had not previously been under serious dispute. Even Haskell, when proposing that sedentary people might just ‘move their bodies around’ (see above), nevertheless concluded that in so doing, they could achieve only ‘somewhat similar’ results compared to ‘higher intensity aerobic training’. Now Blair and Paffenbarger seemed effectively to be implying that if people did any low intensity activity for long enough (duration) they could achieve enough total volume of energy expenditure (kcal) to increase their aerobic capacity in a way that was indistinguishable from that reached and sustained by someone who exercised vigorously (intensity) for, say, 20 minutes, three times a week.

Confirming their commitment to this proposition, Blair and Paffenbarger restated it, with a parenthesis of qualification that seemed only to underscore their near certainty, when they called for further research in their concluding remarks:

“The effects of activity on certain individual health conditions, the precise dose of activity that is required for specific benefits, the role (if any) of intensity of effort, and the elucidation of biological pathways whereby activity contributes to health are topics for further research.The key factor is total energy expenditure; if that is constant, improvements in fitness and health will be comparable.” **(Blair et al 1992 p 120)**

10.2.1.8 Lee et al 1995

Perhaps the most perplexing anomaly lay in the apparent conflict between the evidence and conclusion of Paffenbarger’s 1995 report on his Harvard Alumni **(Lee et al 1995)** that was to emerge during the final months of preparation of the US Surgeon General’s 1996 report. Analysis of the data (see earlier discussion in Chapter 8) within

the study's 'physical activity index' clearly indicated that the vigorous intensity component (and not the total volume of kcal expenditure) was the significant factor in reducing mortality:

"Vigorous energy expenditure again was significantly and inversely related to mortality ($P=.007$), whereas the trend for nonvigorous energy expenditure again was not significant ($P=.36$)" (**op cit p 1181**)

Paffenbarger and Lee also made reference to Morris' latest study (**Morris et al 1990**) and to a similar new longitudinal study from Finland broadly supporting the importance of exercise intensity in preventing coronary deaths. (**Lakka et al 1994**) However, they also mentioned the latest CDC/ASCSM recommendation (extensively discussed in Chapter 8) calling for the adoption of new moderate activity guidelines as the best way to combat the sedentary habits of many Americans. (**Pate et al 1995**)

Apparently disregarding the implications of their own data and those of Lakka et al, Paffenbarger and Lee concluded: "Our findings indicate that sedentary individuals should increase their activity level to enhance longevity. Specifically, vigorous activities were associated with greater longevity." (**Lee et al 1995 p 1183**)

Since 'nonvigorous' (light or moderate) activities were not significantly related to mortality in their study, one might logically expect, therefore, that the authors would at least have encouraged even sedentary Americans at least to aspire to attain some modest bouts of vigorous activity in pursuit of a longer life expectancy (from all-cause mortality). But, incongruously, they concluded instead with an observation about cardiac risk factors: "However, we strongly believe that even nonvigorous exercise is preferable to sedentariness. Our findings pertain only to all-cause mortality; meanwhile, even modest exercise has been shown to improve, for example, lipid and glucose profiles." (**op cit p 1183**)

However, no references for this serum dose-response were given.

10.2.1.9 Summary and Conclusion:

A group of American investigators led by Blair, Powell and Paffenbarger made a concerted, and partially successful attempt to challenge or 'falsify' Morris' vigorous threshold hypothesis. Morris himself helped in this endeavour by re-examining data from his 1990 study and concluding that men, and particularly men over 55, did show significant (albeit less) benefit in heart attack reduction from activities such 'fairly brisk

walking' at intensities lower than Morris' postulated minimum threshold of ≥ 7.5 kcal/min. **(Morris et al 1990 pp 325, 327)** Furthermore, some of the strongest evidence for an alternative 'inverse linear gradient' hypothesis came from the work of Haskell's team. **(Ekelund et al 1988)** And yet, Paffenbarger's latest data, in finding only vigorous activity significantly protective, had apparently swung his evidence back in support of the absolute 'threshold hypothesis'. **(Lee et al 1995)**

A parallel attempt (which will be considered in depth later) both to falsify the vigorous intensity threshold hypothesis and to assert a new 'curvilinear moderate fitness/physical activity' hypothesis was considerably less successful. Only two studies **(Leon et al 1987 and Blair et al 1989)** saw very little increasing benefit from vigorous activity/ higher fitness.

Indeed, the latest data that were being compiled by Blair himself did cause him to change his assessment. No longer was the gradient deeply curvilinear. In contrast he obtained a "strong, graded and independent association of fitness with CVD and all-cause mortality." **(Blair et al 1996 p 210)**

In conclusion, the challenge to Morris' vigorous intensity 'threshold' hypothesis was considerable, and even Morris, himself, found it problematic, particularly among the older members of his British civil servant cohort. Nevertheless, Paffenbarger's latest published assessment of the Harvard alumni data **(Lee et al 1995)** appeared again to suggest that non-vigorous activity gave no significant protection against cardiac and all-cause mortality, and therefore that a 'threshold' of intensity was evident. However, there was other strong evidence, based on both treadmill/fitness and questionnaire designs that the protection rose (and/or risk declined) with a linear increase in physical activity volume (kcal) or fitness (treadmill time), not least in the end from Blair's 1996 data **(Blair et al 1996)**

A substantial amount of evidence indicated that linear increases in physical activity (measured by total volume, intensity and/or fitness) brought significant and increasing (rather than absolute threshold) mortality protection and/or other health benefits to healthy men. Yet, American investigators and policy makers continued to advocate a reduction from vigorous to moderate intensity public health physical activity guidelines without any increase in total volume (kcal) of expenditure. One of their consistently repeated arguments for so doing was that the existing vigorous guidelines were at best, being ignored and certainly not attracting more adherents. At worst, they were deterring

Americans, and especially sedentary Americans from becoming active because these inactive people felt incapable of such intensity of exertion, or that the very existence of vigorous guidelines led them to believe (falsely) that moderate intensity activity had no significant health value. It is to these arguments that we now turn.

10.2.2 To assert that vigorous activity recommendations were effectively harmful in deterring (especially sedentary) Americans from adherence to any physical activity. An early expression of this concern about the alleged ‘deterrent effect’ of vigorous activity guidelines was seen clearly in the lead paper by Powell and Paffenbarger at Powell’s pioneering physical activity and public health workshop held in 1984. **(Powell and Paffenbarger 1985)** They wrote:

“In almost every paper [of the workshop], the paucity and necessity of dose-response information are mentioned. This should not be mistaken for the search for a single optimal level below which there is no benefit and above which one reaps full reward. On the contrary, the interest in dose-response information stems from the recognition that dose is probably inversely related to likelihood of participation and from the necessity to compare benefits and risks (as described subsequently) both of which are almost certainly dose-related. The increase in benefits may be greatest at low levels and diminish with increasing activity. Risks, on the other hand, may be less at lower levels and become increasingly more frequent and severe at higher levels.” **(op cit pp 123-4)**

The alleged ‘deterrent effect’ was then taken up at the same conference by Haskell and colleagues: **(Haskell et al 1985)** They asked a slightly different but related question:

“Since many people would prefer not to have to exercise vigorously to maintain good health, what is the minimum amount of exercise needed to improve health status?” **(op cit p 203)**

However, in neither paper was any evidence or references provided to support their preferred answer. One reason for this omission is that such evidence, in the mid-1980s, simply did not exist, and these were conclusions that were merely the plausible observations and assumptions of men very interested in the public health importance of physical activity who further believed, again plausibly enough, that the sedentary

population, who concerned them most, were among the least willing to follow vigorous exercise recommendations. Nevertheless, these propositions were portrayed as 'warranted' -- based strictly on robust scientific or social scientific facts.

Yet, the absence of evidence for this 'plausible' proposition was demonstrated comprehensively by Powell himself, in his often cited 1987 review of the available scientific literature on physical activity and the incidence of coronary heart disease. **(Powell et al 1987)** As we saw in Chapter 6, only eight of the studies reviewed (19%) contained adequate measures of the intensity, duration and frequency of the activities examined. As for adherence data, even fewer, just 8% of 36 cohort studies "obtained this information or even considered this issue in their analysis." (**op cit p 262**).

Nevertheless, this also plausible, but unsupported, idea that sedentary people were unlikely to perform, or even aspire to, vigorous activity and fitness was repeated two years later by Powell himself, when he co-authored an editorial comment in the *Journal of the American Medical Association (JAMA)* which accompanied Blair's influential 1989 paper on moderate fitness and mortality. **(Blair et al 1989)**

"This finding [Blair's results] makes our health promotion task considerably easier. Inactive individuals are likely to find lower-intensity activities, such as walking, more acceptable than higher-intensity ones, such as running. Lower-intensity activities are likely to be more comfortable, more convenient, more affordable, safer, and thus, more likely to be done."
(Koplan et al 1989)

Again, no references were cited for these 'likely' propositions. Carl Caspersen expressed similar thoughts when he was asked to comment on Blair's findings, which became the front page lead story in the *New York Times* on the same day that they were published in JAMA: He was quoted as saying:

"This is a hopeful message, an important message for the American people to understand. You don't have to be a marathoner. In fact, you get much more benefit out of being a bit more active." **(Hilts PJ 1989 NYT p 1)**

In terms of impact on health professionals and upon the wider American public for a public health message, it is difficult to imagine better combined coverage than **JAMA** and the front page lead in the *New York Times*, arguably America's most authoritative and respected news outlet.

10.2.2.1 The Randomized Controlled Trials

In their comparatively long and large randomised controlled trial, Haskell and colleagues at Stanford unusually included ‘participation rates’ (adherence) as one of three explicitly chosen outcome measures. **(King et al 1991 and 1995)** Their framing assumption was that the group of middle-aged men and women assigned to lower intensity (moderate), home-based ‘lifestyle’ exercise would have the best adherence/participation rates. Two other groups were assigned higher intensity (vigorous) activities – one home-based lifestyle, the other at a gym. Clearly, the investigators did not expect good adherence from those asked to do this vigorous activity. After the first year of their study they observed:

“In practice, it is likely that the majority of middle-aged and older Americans possess neither the willingness nor the ability to exercise at the intensity or duration necessary to achieve the change in functional capacity achieved in laboratory-based training studies.” **(King et al 1991 p 1535)**

And yet the adherence rate outcome by the end of the two year study showed that the higher intensity (vigorous) lifestyle group significantly outperformed (67.8%) the lower intensity (moderate) lifestyle group (49%) – whose adherence rate was nearly as poor as the higher intensity gym based participants. Haskell and his team tried to explain this unexpected result on the requirement for the lower intensity (moderate) group to exercise five times a week, compared to the three days a week required of the vigorous higher intensity groups. **(King et al 1995 online)** And yet the five days a week requirement was the minimum frequency (‘five, preferably more’) that advocates of the emerging new moderate public health guidelines were putting forward to replace the existing three days a week vigorous guidelines.

Yet the authors provided no evident explanation for the inconsistency between their poor adherence results and their advocacy of moderate activity recommendations that could not realistically be done in fewer than 5 days a week (to achieve an expenditure volume of 1,000 kcal/wk) – unless the elapsed time of each daily session were substantiallyly increased, and that, presumably, would hinder adherence similarly.

10.2.2.2 ‘Lack of Time’

Proponents of the view that the American public was deterred by vigorous activities thus seldom addressed an inconvenient anomaly: the reason that people actually gave most frequently in questionnaires and interviews for failing to become more physically active was: not dislike of exertion, but “a lack of time” **(Pate et al 1995 p 403 and**

Pollock ML 1988, p 261 Dishman et al 1985 p 166). The old vigorous guidelines required 1 hour a week (3x20 mins) compared to the minimum of 2 ½ hours (5x30 mins) for moderate activity such as 'brisk walking'.

And yet, what little evidence that did exist appeared to show that, while the majority of American people were not regularly active, those regular participants in moderate physical activity did not greatly exceed in numbers (and arguably were fewer – see below) the regular participants in vigorous activity. The prevalent interpretation of the data was therefore distinctly anomalous. The best data available to investigators and policy makers at the time would have come from the US Department of Health and Human Services' own *Healthy People 2000* rolling review of health targets. **(USDHHS 1995)**

The 1995 update reported: "Both objectives for increased moderate and vigorous physical activity among adults are showing progress." **(op cit p 24)** Based on data from 1991, it recorded that 24% of adult Americans surveyed reported that they engaged in moderate physical activity for 30 minutes on five or more days a week. This compared with 16% reporting vigorous activity for 20 minutes on three or more days of the week. The data even indicated that the reported improvement in adherence from 1985 baseline data was greater (12% -16%) for vigorous activity than for moderate activity (22% - 24%). **(op cit p 34)**

Those data may, however, have exaggerated the gap between moderate and vigorous participation, because it is more likely that the 24% reporting regular moderate activity will have been bolstered by at least some people who were also doing regular vigorous activity as well. The reverse, is less likely to have been true. **(personal communication with KE Powell, Atlanta, Georgia May 2007)**. Indeed, when Powell and Blair made their estimates of public health burdens from sedentary living habits, they went so far as to assign only 10% of the American population to the 'regular moderate' category – thereby subtracting all the remaining 12% and assigning these to the 'regular vigorous' category. **(Powell and Blair 1994 Table 3 p 853)**

10.2.2.3 'Perceptions and Misperceptions'

Nevertheless, the leading investigators and policy makers, who were in positions to influence the outcome of the US Surgeon General's report, continued to argue that vigorous activity guidelines were either deterring Americans, or that this advice was misleading them to believe that less intense activity was of no health value. That was anomalous because those protagonists needed to discount many of the uncertainties in

the evidential support for their interpretation. Blair and Paffenbarger, for example, argued in 1992 that public health campaigns primarily extolling the benefits of vigorous activity were a mistake:

“We believe that these activities have led both the public and health professionals to adopt a dichotomous view of exercise. That is, unless a person achieves the specified exercise prescription, there are no benefits or responses to the training program. In our opinion, this is an incorrect view, especially in terms of the health effects of physical activity.” **(Blair et al 1992 p 115)**

In the following year a workshop convened by the Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM) came to a similar conclusion and spelt out the remedy:

“Why are so few Americans physically active? Perhaps one answer is that previous public health efforts to promote physical activity have overemphasized the importance of high-intensity exercise. The current low rate of participation may be explained, in part, by the perception of many people that they must engage in vigorous, continuous exercise to reap health benefits. Actually the scientific evidence clearly demonstrates that regular, moderate-intensity physical activity provides substantial health benefits.....Every American adult should accumulate 30 minutes or more of moderate intensity physical activity over the course of most days of the week....One specific way to meet the standard is to walk two miles briskly.” **(CDC/ACSM 1993 pp 2-3)**

The word ‘perception’ or subsequently more emphatically, ‘misperception’ was to be repeated, first in what would become the highly influential recommendations of the CDC and ACSM which was published in 1995 as *A Special Communication* in the *Journal of the American Medical Association (JAMA)*:

“The current low-participation rate may be due in part to the misperception of many people that to reap health benefits they must engage in vigorous, continuous exercise. The scientific evidence clearly demonstrates that regular, moderate intensity physical activity provides substantial health benefits.” **(Pate et al 1995 p 404)**

Virtually the same wording re-appeared a few months later when the National Institutes of Health convened its consensus conference on physical activity and cardiovascular

disease which was also prominently published in the *Journal of the American Medical Association (JAMA)*:

“Current low rates of regular activity in Americans may be partially due to the misperception of many that vigorous, continuous exercise is necessary to reap health benefits. Many people, for example, fail to appreciate walking as ‘exercise’ or to recognize the substantial benefits of short bouts (at least 10 minutes) of moderate-level activity.” **(NIH 1996 p 243).**

However, in neither paper were any references cited to provide evidence for this assumption – and nor was any mention made of the *Healthy People* activity intensity/adherence data reported above. Instead, the judgements were portrayed – or one might say ‘mis-portrayed’, as ‘warranted’ assumptions based on reliable scientific or social scientific evidence.

10.2.2.4 Summary and conclusion:

Between 1984 and 1996, a number of leading investigators (including Powell, Paffenbarger, Haskell, Blair and Pate) continued to advance the assumption that existing public health physical activity guidelines, which then advocated vigorous intensity activity, were failing to find new adherents and were actually deterring many sedentary Americans from taking up less intense moderate activities. This assumption was repeated without any substantial evidence – and indeed in the face of evidence to the contrary **(King et al 1995)** suggesting that adherence to the kind of moderate intensity ‘lifestyle’ activity that they were advocating would, in public health terms, be very difficult to achieve, not least because of the frequency and duration (total time required) of their exercise prescription. It is to the argument that moderate intensity guidelines would attract greater adherence that we now turn.

10.2.3 To demonstrate that adherence to moderate intensity recommendations would be substantially higher.

The assumption that adherence, in population terms, to moderate intensity activities would be greater than to higher intensity activities, especially among sedentary people, appears plausible, at least at first glance. After all, sedentary people might *psychologically* be less daunted at the prospect of attempting less vigorous intensity activity. Yet, investigators and policy makers, when making that assertion, seldom offered evidence to support it. Moreover, they appeared to neglect an important

element to the argument: time. As has been stated earlier in this chapter, when questioned about barriers to exercise many sedentary people cited lack of time as the biggest obstacle to their adherence (**Pate et al 1995 p 403, Pollock ML 1988 p 261 Dishman et al 1985 p 166**) And yet the investigators and policy makers who were advocating a switch to moderate intensity public health guidelines nevertheless appeared unanimously to assume that the new prescription to replace the 1 hr of vigorous activity weekly (3 x 20 mins) would have to be at least 2 ½ hrs of moderate intensity activity (5 x 30 mins) to achieve the same energy expenditure (~1,000 kcals). In addition, their new prescription would require not only a substantial increase in duration per bout (from 20 to 30 mins) but also – and this was perhaps the worse feature – the dedication to increase frequency from 3 days a week (hence, most days not exercising) to exercising most, and at least, (5) days of the week

Haskell appears among the first to have espoused the ‘moderate = better adherence’ proposition. Unusually, he did consider the question of increased time required, but only in the sense of a greater time-lag (perhaps weeks or months) before a dose-health response could be expected:

“It appears that it may take a longer time for lower intensity exercise to produce results some-what similar to those frequently observed with higher intensity aerobic training. However, this alternative [lower intensity exercise] might be quite desirable if we are advocating a permanent change to a more active lifestyle, since the lower intensity is more acceptable to a larger portion of our target population and the medical risks are substantially less.”

(Haskell et al 1985 p 207)

No evidence or references were provided to support the assertion that people would be more likely to adhere to a low intensity exercise regime, although it would take considerably longer to achieve a less satisfactory (only ‘some-what similar’) result.

While evidence of greater adherence to moderate activity was at best unclear and incomplete (and at worst, absent) Blair and other leading investigators made a further plausible assumption that because moderate intensity activity was *physically* achievable even for many sedentary Americans, that this ability would translate into them acting upon public health messages encouraging moderate intensity physical activity. Blair et al 1989 said:

“Moderate levels of physical fitness that are attainable by most adults appear to be protective against early mortality.....The strength of the association and the high prevalence of sedentary habits and low physical fitness levels produce high attributable risk estimates and suggest that these characteristics constitute an important public health problem that deserves remedial attention.” **(Blair et al 1989 p 2401)**

Indeed, when subsequently challenged on this adherence question, Blair wrote:

“Part of the thinking was that the availability of a [moderate intensity] alternative might be useful in getting some sedentary people to become more active, but we all certainly knew that we did not have evidence for that point. The evidence was and is that moderate amounts and intensities of exercise have health benefits, and this seems to be useful information to communicate to health professionals and the public.” **(personal communication with SN Blair, Spring 2001)**

Investigators such as Duncan, a colleague of Blair at the Cooper Institute, repeated this ‘moderate = better adherence’ claim even when their own data belied it. “Low to moderate physical activities have greater compliance rates than more vigorous exercise activities, are more easily incorporated into one’s daily life-style and are well maintained over time.” **(Duncan et al 1991 p 3299)** Yet, as was reported in a previous chapter, all three walking groups in Duncan’s 6 month study (strollers, brisk, and the fastest, aerobic) had identical adherence rates, 85%. The aerobic walkers were instructed to walk at 8 km/h – a speed that would have demanded vigorous aerobic intensity, especially as all the women were classed as sedentary at baseline.

The 1993 workshop on physical inactivity sponsored by the American Heart Association, came to much the same conclusion as Duncan et al 1991, albeit again without any cited supporting evidence:

“Moderately intense activities are.....more likely to entice sedentary and unfit individuals to participate and persist and are less likely to require medical supervision than if the only focus is on more vigorous sports activities....Moderate levels of physical activity such as brisk walking should be promoted and the functional and health benefits of such activities emphasized. Life-style interventions in which increased activity is integrated into daily routines may be easier for many people to adopt than traditional programmed exercise.” **(AHA 1993 p 1403)**

It is perhaps not surprising, therefore, that the two major ‘consensus conferences’ that preceded and informed the US Surgeon General’s report (**CDC/ACSM 1995 and NIH 1996**) were also unequivocal in their advocacy of the revised proposition. However, the assertions, once again, were made without cited scientific or social scientific evidence to support them:

“Low to moderate-intensity physical activities are more likely to be continued than high-intensity activities.” (**Pate et al 1995 p 403**)

“Many people, for example, fail to appreciate walking as ‘exercise’ or to recognize the substantial benefits of short bouts (at least 10 minutes) of moderate-level activity.....Moderate-intensity activity performed by previously sedentary individuals results in significant improvement in many health related outcomes. These moderate-intensity activities are more likely to be continued than are high-intensity activities.” (**NIH 1996 p 243**)

Finally, as was seen in the last Chapter (9), the US Surgeon General’s Report strongly recommended the 5+ days/wk 30 minute moderate activity guidelines, despite briefly acknowledging (in reference to King et al 1995) that even in a controlled trial where motivation was presumably high, 5 days a week of 30 minute moderate exercise proved too daunting or discouraging for a high proportion of the participants. (**USSG 1996 p 226**)

10.2.3.1 Summary

For more than a decade (1984 – 1996) prominent physical activity investigators (most notably led by Blair, Haskell, Paffenbarger, Pate and Powell) claimed that Americans, and particularly sedentary citizens, were more likely to adopt and adhere to guidelines advocating moderate intensity activity than the existing vigorous guidelines. However, seldom if ever did they provide evidence or scientific citations to back this assertion, which, with rare exceptions (**Williams, PT 1995, Winett RA 1995**) went largely unchallenged. Confidence in the improved adherence attraction of moderate intensity activities was only part of the new public health ‘paradigm’. Advocates of the new policy were also searching for and compiling new evidence that the cardiovascular and other health benefits of moderate intensity activities were significantly greater than had been previously supposed. It is to this argument that we now turn.

10.2.4 To claim that this alleged 'deterrence' (by existing vigorous guidelines) was all the more damaging because the health protection/disease prevention benefits of moderate intensity activity had been both under-valued and insufficiently investigated.

10.2.4.1 The perceived need for further study

Powell, in his inaugural public health workshop in 1984, urged increased study of lower intensity activities because 'it appeared likely' that they were undervalued.

"The effect of low-intensity activity, such as walking, is of great interest. It appears likely that the greatest gain in the risk-benefit relationship per unit change in physical activity occurs at the lower end of the activity spectrum."

(Powell and Paffenbarger 1985 p 124)

At the same workshop Haskell suggested: "...low-intensity dynamic activity (less than 60 percent VO₂ max) can reduce stress, contribute to weight loss, or improve selected biochemical reactions..."**(Haskell et al 1985 p 205)** This claim was not supported with citations or evidence, and as has already been observed, <60 percent VO₂ max, was not normally classed as 'low-intensity' activity. In fact ~50% VO₂ max was classed as 'vigorous' by the US Department of Health and Human Service **(USHSS *Healthy People 2000*, 1995 revision p 38)**

Haskell went further, postulating that a very small increase in activity among sedentary people could bring quite significant, indeed dramatic health benefits in a concave curvilinear fashion, with much less achieved by more intense effort:

"In most cases, the major differences in the incidence of coronary heart disease are between those people who do almost nothing and those who get some form of exercise (by moving their bodies around) on a regular basis." **(Haskell et al 1985 p 208)**

Again, no evidence or references were presented to defend the assertion that the greatest health benefits are achieved at the lower levels of activity, and with "...much less effect apparent between the moderately active and the very active." **(op cit p 209)**

Siscovick's review of the literature led him to the unequivocal conclusion that vigorous intensity activity had clearly been demonstrated to reduce cardiac deaths. But he argued that the evidence base was incomplete because the benefits of more moderate intensity activity had not been adequately explored and tested:

“...Whether vigorous activity, such as jogging, that results in physical fitness is necessary to achieve the disease-specific benefits of physical activity remains unclear, because previous studies have not adequately examined the relationship between less intense activity, such as walking, and these diseases.” **(Siscovick et al 1985 p 187)**

10.2.4.2 Selective Interpretations

Another frequent and important anomaly occurred in the way that the authors of numerous key papers appear systematically to have chosen selectively to highlight certain of their chosen outcomes, to the relative exclusion of others, with the result that the studies disproportionately flattered the benefits of moderate intensity activity. As previously discussed, two randomized controlled trials in the early 1990s comparing exercise intensity and health outcomes were prominently quoted in the literature **(Duncan et al 1991 and King et al 1991, 1995)**. While their study designs inevitably differed, in effect both Duncan and King (colleagues of Blair and Haskell, respectively) broadly chose to compare how the intensity of exercise affected three health outcomes in adult sedentary Americans: Cardiorespiratory fitness (measured by treadmill test and VO_2 max); cardiovascular risk factors, including HDL cholesterol; and adherence or participation rates. It has been argued earlier, that both teams (and more explicitly King's) believed that the groups in their sedentary populations who were given moderate intensity regimes would do best, not least by the measure of adherence rates.

However, this did not prove to be the case. On only one of the three measures did the less intensive groups do particularly well: improvements in HDL cholesterol. On aerobic fitness, the less strenuous regimes did least well, and the more intense, the best. For Duncan, adherence was not strictly a stated health outcome. Nevertheless, discussion was sparse (just a single sentence): “Compliance to training (total number of sessions attended divided by total number of sessions possible) exceeded 85% for all three walking groups.” **(Duncan et al p 3296)** One of King's three exercise groups (higher intensity gym/group based) performed the worst, as predicted, in adherence rates. But the clear winner, was not the lower intensity ‘lifestyle’ group, as the authors had hopefully forecast, but the higher intensity ‘lifestyle’ group, by a highly substantial margin.

Nevertheless, this balance of empirical outcomes was not reflected in the reports' conclusions, which both concentrated on the improved HDL profiles of the non-

vigorous, less intense exercise groups. Moreover, neither study mentioned that their HDL outcome was at odds with other recent studies which showed that improved HDL profiles were seen most strongly among vigorous exercisers. **(see for example Blair et al 1983, Folsom et al 1985 and Rippe et al 1988)**

Other examples of 'selective interpretation', also discussed in the previous chronological narrative, appear to have been in the results described by teams led by Haskell and Paffenbarger. **(Ekelund et al 1988 and Lee et al 1995)** In both longitudinal studies the more intense exercisers (fittest or most vigorously active) had much the better mortality rate reductions. Yet nonetheless the authors both chose, in their concluding paragraphs, to emphasize the health benefits of more moderate physical activity. Similarly, Blair found a very clear inverse linear association between fitness and mortality in his extended 1996 study of his ACLS cohort. Yet he did not discuss, explain or explore why this gradient so significantly differed from the steep concave curvilinear slope of his 1989 paper, a finding that lead the front page of the New York Times and would become the cornerstone study underpinning the moderate intensity hypothesis. **(Blair et al 1996, Blair et al 1989)**

One of the few contemporary dissenters from the 'moderate-volume' hypothesis, Richard Winett **(Winett RA 1995)**, was subsequently highly critical of the anomalous distortions and conclusions that arose from this kind of selective interpretation in the literature that so heavily influenced the US Surgeon General's 1996 report in favour of moderate intensity activity:

"A reasonable conclusion from the entire epidemiological base is that there is some evidence for the benefits of nonvigorous activity, stronger evidence for the risk reduction benefits of vigorous activity, and much stronger evidence for the benefits of a greater aerobic capacity." And yet: "The belief in this axiom [the volume hypothesis or 'total caloric expenditure axiom'] seems to cloud interpretation of seminal studies, with those studies then cited in public health guidelines to support the axiom." Further: "Thus, the total caloric expenditure 'axiom' – an axiom without much support – influences the assumptions, measurement strategies, interpretations of results, and ultimately the recommendations emanating from otherwise soundly conducted research." **(Winett and Carpinelli 2000 pp 238-40)**

10.2.4.3 Aerobic capacity

Advocates of the moderate intensity or volume hypothesis tended to deal with the issue of aerobic capacity in one of three ways: 1. to argue that the importance of aerobic capacity, in terms of health as opposed to mere fitness, had been over-rated (being the favoured measure of exercise physiologists) as compared to other risk reduction factors for heart disease such as HDL cholesterol: 2. to maintain that significant improvements in aerobic capacity gained from moderate intensity activity had been relatively overlooked and/or understated: 3. or finally, and in the extreme, to argue as Blair and Paffenbarger had done, that an identical increase in aerobic fitness could be achieved by any intensity of activity. Duration alone (total volume kcals) was sufficient. **(Blair et al 1992 p 102, p 120)**

10.2.4.4 Population Attributable Risk (PAR)

It might be important to consider: should, indeed can, a public health message or prescription be built exclusively on the empirical scientific evidence available? Or should it rather be 'based' on that science, but also be 'socially crafted or constructed' (implicitly or explicitly). The aim thus might be to produce the greatest total benefit to the entire audience or population – perhaps by drafting and offering guidance which might, if not yet (and perhaps may never) be supported by sound clinical evidence, or at least not until it had been followed. Might such guidance nevertheless appeal to, and be taken up by, the section of the population which might benefit most from adhering to the advice – as opposed to doing taking no action at all?

It seems clear that many of the investigators and policy makers in the field of physical activity were increasingly focused on the growing number of sedentary Americans (those most at risk) whom they perceived to be capable of doing moderate intensity activities, but who were otherwise thought to be deterred by any activities more intense. Moreover, these investigators were eager to show/suggest that the health benefits of moderate activity (especially for sedentary people) were greater than had been previously thought and/or that the benefits of vigorous intensity activity had been over-rated. Given these assumptions, it is perhaps not surprising that they would seek evidence of a mechanism that would justify their new moderate intensity (volume) hypothesis. As was seen in Chapter 8, Powell and Blair applied an emerging tool of epidemiology, population attributable risk (PAR), to add scientific credence (or 'warranted authority') to the new hypothesis.

However, as the authors acknowledged, assumed values in any PAR are, to a large extent 'estimates' which may, to a greater or lesser extent, be imprecise and thus unreliable:

"Using the epidemiologic construct of population attributable risk (PAR), we estimate the number of deaths due to coronary heart disease (CHD), colon cancer, and diabetes that are caused by insufficient physical activity....Empirically determined RRs [relative risks] for these categories of physical activity are not available. The 'true' value of the RR for different 'doses' of physical activity is, of course, being debated." **(Powell and Blair 1994 p 851, p 853)**

The 'construct' they chose when assessing CHD was to assign a relative risk (RR) of 2.0 to sedentary lifestyles compared to regular vigorous activity, with a referent risk of 1.0. Thus, sedentary individuals were assumed to be twice as likely (2X) to die from CHD than those who practiced regular vigorous exercise. However, the authors' decision to assign a relative risk of 1.1 to regular moderate activity (**op cit table 3 p 853**) seems unusually arbitrary for two reasons: First, the only cited reference for this assumption was Powell's own 1987 review (**Powell et al 1987**). And, as we have seen, Powell lamented that only eight studies (19%) that he examined provided adequate measures of intensity, frequency and duration. Second, one page later in a similar table (**Powell and Blair 1994 table 4 p 854**) Powell and Blair chose (for reasons unexplained) to assign a RR of 1.2 to regular moderate activity. Powell also used this higher estimate (1.2) a year later in his presentation to the 1995 NIH *Consensus Conference on Physical Activity and Cardiovascular Health* (**Powell KE 1995**)

A further uncertainty lay in Powell and Blair's decision to assign only 10% of American adults to the category of regular moderate intensity activity (while allocating 12% to regular vigorous) -- apparently abandoning, or at least weakening, their claims made previously that Americans preferred moderate intensity activity to vigorous.

However, with these decisions the authors thus implied firstly, that the differences in CHD risk benefit between moderate and vigorous intensity activity were minimal, and secondly that, in population terms, only negligible gains in public health would be made if focus were targeted to convince the relatively few 'regular moderates' to become 'regularly vigorous'.

10.2.4.5 The Workshops and Conferences 1990 – 1995

A rapid shift, emphasising the emerging benefits of light to moderate intensity activities, was also seen in the examinations and conclusions of the major workshops and conferences on physical activity and cardiovascular health in the five years preceding the US Surgeon General's 1996 report.

In 1990 the American Heart Association appeared equivocal, uncertain and ambiguous in its statement on exercise to health professionals. Its primary advice remained that the 'training effect' (on the cardiorespiratory system) was most apparent from vigorous intensity activities exceeding 50% of VO_2 max. But somewhat ambiguously, the statement also said: "Brisk walking at 50% of capacity [VO_2 max] may be as beneficial as jogging and running." **(AHA 1990 p 397) (emphasis added)**

By 1992, when Steven Blair and Carl Caspersen were invited to be co-authors, the balance of the statement shifted heavily toward moderate intensity activities. As was seen (in Chapter 8) references to the benefits of vigorous intensity activity became few and imprecise, while concerns about consequent cardiac risks were heightened. The 1992 position statement opened simply with: "Modest levels of physical activity are beneficial." **(AHA 1992 p 340)** This knowledge claim was unreferenced and the terms 'modest' and 'levels' were not defined but remained ambiguous. Further, while including the usual caveat that more research was needed, the authors now urged health professionals and teachers to recognise the importance of low to moderate intensity activities:

"In addition, physicians should encourage their more sedentary patients to adopt a more active lifestyle and emphasize the risks associated with inactivity. Walking should be advocated as a form of exercise." **(op cit p 342)**

Educators must also encourage all their students to participate in physical activity, and not just the gifted elite:

"Schools at all levels should develop and encourage positive attitudes toward physical exercise...The school curriculum should not overemphasize sports and activities that selectively eliminate children who are less skilled." **(op cit p 342)**

The AHA Physical Inactivity Workshop, led in the following year by Blair and Powell **(AHA 1993)** did acknowledge that: "High-intensity activity may be necessary to achieve maximum benefit" [in reducing heart disease risk]. **(op cit p 1402)** But the workshop

report also questioned the validity of the evidence that underpinned this public health assumption:

“Most promotional efforts have advocated vigorous activity, that is, activity requiring 50% to 60% or more of the cardiorespiratory capacity of young people (eg, running, swimming laps). However, of the many studies showing that regular activity is associated with a reduced risk of coronary heart disease, very few have demonstrated that such intense activity is required.” **(op cit p 1402)**

However, some ambiguity, or at least uncertainty, remained:

“Efforts to get the least active people to do something will provide them with benefits whether or not they meet traditional exercise guidelines. This does not mean, however, that modest amounts of activity provide maximum reduction in coronary heart disease risk.” **(op cit 1403)**

This comment seemed at odds with their dismissal, above, of the evidence that intense activity was required to benefit from coronary risk reduction. Moreover, the authors failed to quantify, or even describe, what ‘benefits’ they believed derived from these ‘modest amounts’ of activity.

There followed the CDC/ACSM workshop draft summary (1993) and the Strategic Plan for physical activity drafted by the American Heart Association (1994-1995). Both reports lent support to the US Government’s then (1991) current moderate intensity physical activity targets **(USDHHS *Healthy People 2000*)**. Yet both, anomalously, failed to mention the equally prominent and parallel vigorous intensity targets for adults in the *Healthy People 2000* report. These were instances where the benefits of moderate intensity activity were not only emphasised and highlighted, but the official public health targets for vigorous intensity were effectively expunged.

10.2.4.6 The Governmental ‘Consensus’ Conferences: Pate et al 1995, NIH 1996:

The CDC/ACSM consensus panel **(Pate et al 1995)** and the National Heart, Lung and Blood Institute consensus development panel in December 1995 **(NIH 1996)** have been examined earlier at considerable length, so only the key uncertainties, ambiguities, and anomalies that they identified will be summarised briefly here.

A New ‘Physical Activity – Health Paradigm’

The members of the CDC/ACSM consensus panel were effectively self-selected, and they were, overwhelmingly, enthusiastic endorsers of what they described as the new “physical activity-health paradigm”. **(Pate et al p 405)** Its tone was unashamedly populist and its message one of enthusiastic advocacy that moderate amounts (~1,000 kcals/wk) of moderate intensity activity was the new, accessible and enjoyable elixir for America’s public health. The panel report said:

“The focus of this article is on physical activity and the health benefits associated with regular, moderate-intensity activity....Moderate physical activity is activity performed at an intensity of 3 to 6 METs (work metabolic rate/resting metabolic rate) – the equivalent of brisk walking at 3 to 4 mph for most healthy adults.” **(op cit p 402)**

However, the robustness of the science underpinning its adoption of the new ‘paradigm’ was questioned. Months after its publication, Winett observed that while the effective scrapping of vigorous intensity guidelines in favour of apparently easier moderate intensity targets might be “seemingly well-intentioned....the public health message they deliver may be problematic and potentially counterproductive from both scientific and public policy perspectives...” **(Winett RA 1995 p 534 and personal communication with RA Winett March 2007)** More recently, JN Morris, who was a co-author of Pate et al 1995, said he only agreed in the end to sign the document because he knew he was up against an overwhelming and unified consensus: “I was a victim of group psychology and just exhausted”, he said. **(personal communication with JN Morris, London, December 2006)**. Adele Franks, who, in conjunction with Steven Blair, co-edited the *US Surgeon General’s Report on Physical Activity and Health 1996*, described Pate et al 1995 as “well out on a limb....basically an advocacy piece which was not properly cleared by CDC.” **(personal communication with A Franks, Northampton Massachusetts, May 2007)**.

While the NIH 1996 consensus statement **(NIH 1996)** also embraced much of the new moderate activity ‘health paradigm’, it did not repeat the term, and it was more cautious in its evaluation of the health benefits of vigorous intensity activity than the CDC/ACSM consensus conference. As has been demonstrated in Chapter 8, Blair, Pate and Paffenbarger played prominent roles on the NIH conference’s planning committee and were therefore instrumental in choosing the 27 investigators asked to present papers. But they, and others with ‘strong advocacy’ positions were barred by NIH rules from serving directly on the pivotal consensus panel which actually wrote the conference’s final report. **(NHLBI bundle 05/30/ 1995)** Nevertheless, the final report

did appear to accept much of the 'Blair hypothesis' that the greatest gains in cardiovascular risk reduction could be seen between the sedentary and only moderately active – with comparatively less benefit gained by higher fitness or regular vigorous intensity activity:

“The most active individuals have lower cardiovascular morbidity and mortality rates than do those who are least active; however, much of the benefit appears to be accounted for by comparing the least active individuals to those who are moderately active. Further increases in the intensity or amount of activity produce further benefits in some, but not all, parameters of risk.” **(NIH 1996 p 243)**

10.2.4.7 Summary and Conclusion

During the 12 years prior to the US Surgeon General's Report considerable efforts were made in several different and contestable ways to enhance the apparent health benefits of moderate intensity activities beyond what the available evidence could reasonably bear.

At Powell's inaugural public health workshop in 1984 it was claimed, without external citation, that the merits of moderate intensity activity had been both undervalued **(Powell and Paffenbarger 1985, Haskell et al 1985)** or insufficiently studied **(Siscovick et al 1985)** and thus the evidence was incomplete.

Later, several investigators appear to have selectively interpreted their own results to favour moderate intensity activity. **(Ekelund et al 1988, Duncan et al 1991, King et al 1991, 1995, Lee et al 1995, Lee and Paffenbarger 1995 and Blair et al 1996)**.

Blair and Paffenbarger, again without evidential support, claimed that intensity and duration were entirely interchangeable and thus, that low-to-moderate intensity activities had identical health benefits to vigorous intensities, if simply done for a longer durations. **(Blair and Paffenbarger 1992 p 102)**. This 'warranted assertion' conflicted, however, with the contemporary exercise physiology literature.

Powell and Paffenbarger made high estimates of the relative risk reduction of moderate intensity activity which were arbitrary and uncertain. **(Powell and Paffenbarger 1994, Powell KE 1995)**.

The workshops and conferences of the early 1990s made repeated, unreferenced and often ill-defined, and thus ambiguous claims along the lines that “modest levels of activity are beneficial”. **(AHA 1992)**

Three workshops and conferences **(CDC/ACSM 1993, AHA 1995, Pate et al 1995)** claimed their adherence to the moderate intensity activity targets set by the US Department of Health and Human Services *Healthy People 2000* report while they all anomalously neglected even to mention its parallel vigorous intensity targets.

The participants at the Centers for Disease Control/ American College of Sports Medicine consensus panel **(Pate et al 1995)** even went so far (evidently borrowing from both Kuhn and Popper) as to claim that they had advanced a new ‘physical activity – health paradigm’ whereby the old vigorous intensity health prescription had been effectively ‘falsified’ and could safely be replaced with the new public health advice to walk briskly, for 30 minutes on 5, and preferably all days of the week.

And finally, the US Surgeon General’s Report, as extensively examined in the last chapter (Chapter 9), chose often to ignore the question of exercise intensity – and when it did examine the issue, it chose exceptionally and selectively to highlight rare studies (such as those quoted for hypertension) where moderate intensity activities appeared to provide equal or even superior health outcomes.

10.3 The 3 Areas of ‘Uncertainty’ and ‘Ambiguity’: Research Question 1

10.3.1 To examine discrepancies between investigators over definition of the ‘brisk walk’ as first defined by Morris.

One of the most intriguing aspects of the post war debate over exercise and formulation of public health guidelines for physical activity was the diametrically different ways that the ‘brisk walk’ was measured and used to defend both of the two opposing exercise hypotheses: vigorous intensity threshold and moderate intensity/volume. (See discussion of Morris et al 1973 in Chapter 5 for list of studies defining “brisk walks”)

Morris, who first described and defined the concept of a ‘brisk walk’, saw it as an activity that would appeal to almost everyone, was easily accessible and affordable (“easy, natural...and enjoyable”) – and yet managed (just) to reach the vigorous intensity threshold (≥ 7.5 kcals/min) which he held to be crucial in significantly reducing

the rates of coronary heart disease and mortality. **(Morris et al 1973 p 334)** In terms of speed, Morris specified that the 'brisk walk' on a flat surface would need to be greater than 4 miles per hour (>4 mph/6.5 km/h). Crucially, the brisk walk would be defined, or at least described, on many subsequent occasions by other investigators – but only at speeds of 4 mph/6.4 km/h or slower. The concern of investigators including Paffenbarger, Blair and Pate was most often not threshold intensity, but the total volume of expenditure, which they saw as the key to coronary risk reduction. As such, the 'brisk walk' was described as an enjoyable activity which could be done frequently and for fairly long spells (hence to reach a total volume of expenditure) even by sedentary adults who were prone to avoid any exercise they deemed strenuous. By reducing the speed of their 'brisk walks' to as low as 3 mph/4.8 km/h, the activity was described as 'light or moderate', ideal for their new moderate intensity public health prescription. As Powell observed, wryly: "Yes, I think the concept of the brisk walk lost a little speed when it crossed the ocean." **(personal communication with KE Powell, Atlanta, May 2007)** For example, Blair and Paffenbarger set a pace of 3-4 mph in their own 1992 polemical review *How Much Physical Activity is Good for Health?*:

"The moderate level of physical fitness that is associated with much lower death rates than the low fitness level in the Aerobics Center Longitudinal Study **[Blair et al 1989]** can be achieved with relatively little activity. A brisk two-mile walk in 30-40 minutes (3-4/mph) taken on most days would be sufficient to produce the moderate fitness level defined in the study." **(Blair et al 1992 p 115).**

The CDC/ACSM consensus panel **(Pate et al 1995)** ambiguously defined a 'brisk walk' as between 3-4 mph on one page **(op cit p 402)** only to re-define it two pages later as walking 2 miles in 30 minutes, and hence 4 mph precisely. **(op cit p 404)** Perhaps even more ambiguously, three important conference reports, simply advocated 'brisk walking' **(AHA 1992 p 341, AHA 1993 p 1403)** or just 'walking' **(NIH 1996 p 243)** without attempting to define either speed or intensity.

Some of the ambiguity may, of course, be explained by the fact that advocates of the new 'moderate hypothesis' had rejected the intensity 'threshold hypothesis' and thus were not particularly interested in precise speed or intensity. Second, on both sides of the debate, investigators were aware of the problem of relative intensity: that even within a relatively homogeneous cohort, such as Morris' civil servants, many factors (age, gender, fitness, underlying illness, even psychological inclination to exercise) could alter both the actual and perceived or 'relative' intensity of energy expenditure

that might be deemed 'vigorous', as opposed to a more objective or absolute, and precise measure (≥ 7.5 kcal/min). And, of course, even such an independent measure was itself dependent, for example, upon varying body weights carried when the activity was conducted. Heavier people would expend the minimum kcal/min threshold at a slower walking speed (intensity) because of the greater weight they carried.

When he considered the most obvious variable, age, Morris observed back in 1973:

"Since the maximum aerobic output, cardiac output, and heart-rate all decline with age, a sliding scale of effective exercise – lighter for men in their sixties than in their forties – must surely be postulated." **(Morris et al 1973 p 337 and see Morris 1992 p 247, 253)**

Ambiguity may also, to a certain extent, be explained by the use of language that was and remains unclear in its meaning. As has been observed, Morris in his later investigations actually considered his intensity threshold to be only "moderately intense" **(Morris et al 1990 p 331)** that embraced many activities which were enjoyable and easily attained by most of his cohort, and indeed, by most of the British people. It is the subject of cohort selection that is next examined.

10.3.2 To explore whether cohort selection distorted comparisons and confused interpretations?

Concern was frequently expressed about cohort selection (both in the US Surgeon General's 1996 Report and in the post-war scientific and policy literature that preceded it):

"Much of the research summarized is based on studies having only white men as participants; it remains to be clarified whether the relationships described here are the same for women, racial and ethnic minority groups, and people with disabilities." **(USSG 1996 p 85)**

For example, the US Surgeon General's Report summarised the findings of 55 separate studies which investigated the association between physical activity/or cardiorespiratory fitness and cardiovascular and coronary heart disease. With the notable exception of Blair et al 1989, which has been discussed in detail, only two other studies included women, and both of these were foreign cohorts (Israeli and Finnish) in community studies, similar to the Framingham Heart Study, where physical activity was not the lone focus. Only one very early study (1971) conspicuously included an ethnic

minority (black adult males in Evans County, Georgia) and even though it too was a community study, it specifically excluded women. **(USSG 1996 pp 92, 94)**

Overwhelming attention was, therefore, given to the health impact of physical activity on healthy, able-bodied, relatively affluent, white, middle-aged males, to the relative exclusion, or similar examination of, the dose-response needs and reactions of other groups including: children and the elderly, women, ethnic minorities, and the poor. Also, little consideration was given to the variable genetic capability of individuals to respond to physical activity **(Bouchard C 1995, Bouchard and Rankinen 2001)** and to those with underlying (asymptomatic) or overt disease and/or disability. This apparent imbalance perhaps stemmed primarily from the historical concentration on largely white-male occupational epidemiologic studies which began in the post-war years. Epidemiologists depend on good medical records, and these were primarily kept in occupations dominated by 'healthy' male workforces. **(personal communication with RS Paffenbarger, Berkeley, California, August 2002, and JN Morris, London, April 2004).**

Foremost of these investigations were the early and primary studies of Morris (London busmen) and Paffenbarger (San Francisco longshoremen/dockers), and also included those by Taylor and Keys (US railroadmen). Yet, even when Morris and Paffenbarger moved away from occupational studies to leisure time physical activity investigations, they chose populations (British civil servants and Harvard alumni) which were exclusively male.

Women's virtual exclusion from specific published, physical activity studies until 1989 could not have been random chance, or careless neglect.

Furthermore, while Morris and Paffenbarger were, unusually, physicians with keen interest in public health, the wider field of the study of human physical activity had previously been dominated by exercise physiologists, whose primary interest was the training and performance of elite athletes, who were, in most sports of the period, once again, overwhelmingly male.

The study of the impact of physical activity on human health was, and to a lesser extent remains, dominated by a single health outcome: the prevention of coronary heart disease and death, as is most clearly evidenced by the US Surgeon General's report (1996) itself. Not only was CHD/CVD the biggest single cause of death and a rising

epidemic in the second half of the 20th century, but prevalence of the illness was much more common among men than women. **(Ekelund et al 1988 p 1380)** Further, the men most susceptible to cardiac disease and death, according to available statistics at the time, were white and most probably in the higher socio-economic classes – hence, all the more reason to design studies that featured these individuals. **(Health, United States, 2006)**

Nevertheless, the principal investigators and policy makers did express concern that the cohorts they selected, or reviewed, may not have been entirely representative of wider populations – indeed, for reasons other than gender. This concern did, at least heighten when focus switched from occupational studies to leisure time physical activity. Morris, in his landmark paper of 1973 observed:

“The population studied is restricted so replication in others is urgent. This one seems to be characteristically white collar, and middle-class, very stable, and with much evidence of social responsibility, leading a home-and-family centred life (well over 90% are married), at the expected standard of living (over 40% had central heating, over 80% a car, and over 90% a garden. But it is very ‘upwardly mobile’ (fathers overwhelmingly were manual workers) and shows other unusual features – for example, the large numbers with a disabled person living at home.” **(Morris et al 1973 p 338)**

Yet, for all his insight and sensitivity, Morris did not appear to see the need to explain why his cohort was 100% male, and whether, therefore, it might be a good idea to conduct similar studies with females.

Paffenbarger appeared to suffer the same lapse, when he queried how representative was his Harvard Alumni cohort:

“The Harvard alumni may not be typical of the general population. Their age-specific death rates from each major cause except suicide were roughly half the 1980 rates for white males in the United States. (In contrast, rates of self-destruction among the alumni were 50 percent higher than suicide rates in the general population).” **(Paffenbarger et al 1986 p 612)**

It took Powell, with his focus on public health, to make the obvious point in his 1987 review on physical activity and coronary heart disease:

“Earlier researchers focused on occupational activity. Twenty of the 24 studies conducted before 1970 examined only occupational activity. In contrast only 3 of the 19 analyses done after 1969 examined only occupational activity....Since few studies provide information about women or older men, it is important to determine whether the association (between physical activity and coronary heart disease) holds for them as well as middle-aged men.” **(Powell et al 1987 p 255 and p 282)**

As noted in an earlier chapter, Ekelund and colleagues clearly recognised the shortcomings of having an all male cohort. However, they reported:

“Because of the small number of nonwhites and very elderly subjects, and because of the low incidence of cardiovascular death among women, the present study was restricted to white men 30 to 69 years of age at base line.” **(Ekelund et al 1988 p 1380)**

As also noted, Blair and colleagues in 1989 produced the first major physical activity study in which both genders were studied, although women were still outnumbered 1:3, and he was clear that the cohort was further imbalanced with respect to class and ethnicity: “Patients in this study are from middle to upper socioeconomic strata; approximately 70% are college graduates. Most are employed in profession, executive or white-collar positions. More than 99% are white.” **(Blair et al 1989 p 2396)**

Steven Blair, when asked to look back to the work of others in the post-war decades, and to his own later work in the 1980s, observed:

“Well, they were men of their times. Whether there was a systematic bias in medical science, [only] God knows. But women have been abused by medical assessment. And it was established that more men, at a younger age, had heart attacks than women. And yes it’s one thing for a 75 year old women who is not the bread winner – and another for a fifty year old man [who is the breadwinner] to die of a heart attack.” **(personal communication with the SN Blair, London, November 2004)**

He further observed, from a study design point-of-view, that women then had (and still do have) the characteristic of living longer than men, and thus, for epidemiologists, their crucial end point at follow up - namely death - was inconveniently delayed.

As was seen in Chapter 8, in 1992 Morris openly questioned whether cohort differences could, at least in part, explain why his sample of British civil servants

benefited little from exercise intensities below the ≥ 7.5 kcal/min threshold while the American cohorts of Paffenbarger, and to a far greater extent Blair, showed significant mortality risk reduction with very little improvement in fitness or total volume (kcal) of activity. **(Morris JN 1992)** That said, Morris believed his own civil servants to be rather ordinary chaps, at least by British fitness standards, as has been seen in his 1980 paper:

“In the nature of it, although ‘vigorous’, the self-chosen, self-regulated, and presumably enjoyable activities that make up VE [vigorous exercise] sports are by no means extreme – our men are no athletes. Indeed, the remarkable ordinariness in so many respects of the VE men is further encouragement.” **(Morris et al 1980 p 1210)**

Nevertheless, by 1992, after Paffenbarger and Blair had published their first major works **(Paffenbarger et al 1986 and Blair et al 1989)** Morris asked:

“Could it be that the American cohort is basically less active and less fit than the British and thus capable of benefiting from less intense exercise?....Comparative physiological studies on American and British men could be rewarding.” **(Morris JN 1992 p 249).**

Morris also expressed further concern that so little had been done to study poorer populations who were often the least active and consequently would benefit from exercise most:

“.....aetiological (sic) studies are urgently required in other social and occupational samples, particularly among the lower socio-economic groups, to aid formulation of population strategy.” **(op cit 252-53)**

10.3.2.1 Summary

Women, children, ethnic minorities, the poor and the elderly were un- or under-represented in the major epidemiological studies that preceded and helped frame the US Surgeon General’s 1996 Report. Concern about this imbalance was expressed by several of the leading investigators – most notably by Powell and Morris – but the result was that public health decisions on physical activity were routinely taken from data that did not adequately reflect the wider populations to which they were aimed.

10.3.3 Did 'loose' or 'vague' terms in measuring physical activity also have distorted comparisons and confused interpretation of data and evidence?

In his 1987 review Powell lamented that too few studies were precise in their measurement of two key aspects of physical activity: intensity of, and adherence to it. In addition, however, it would appear that a frequent flaw of many studies was also their failure uniformly and consistently to impose precise definitions on their terms of measurement.

Morris, unlike some investigators, chose a precise, quantitative definition of 'vigorous' or 'strenuous' activity: ≥ 7.5 kcal/min – which was his 'minimum threshold' for protective cardiac effect. **(Morris et al 1973)** As we have seen, his early and precise definition of the 'brisk walk' (at a speed of > 4 mph or > 6.4 km/h) failed to find universal acceptance. He also attempted to define a precise 'relative' measure of intensity, by suggesting that vigorous should be defined as $\geq 60\%$ of an individual's aerobic capacity ($VO_2\text{max}$). Broadly however, these definitions came to be accepted within the field as measures of 'vigorous' intensity activity.

By contrast, other definitions for moderate and low intensity activity were much less precise. Haskell, for example, used the term 'low-intensity' to describe any activity which was 'less than 60 percent VO_2 max' – thus missing out any 'moderate' activities altogether. **(Haskell et al 1985 p 205)** It is difficult to dismiss this imprecision as a mere semantic lapse, since the public health debate hinged on the physiologic response that each dose of activity could bring – and intensity was most often a key, if not the most important element of, argument about the dose.

Powell and Paffenbarger used 'low intensity' in a similarly vague way: "The effect of low-intensity activity, such as walking, is of great interest," **(Powell and Paffenbarger 1985 p 120, p 124)** even though walking was much more commonly described as of moderate intensity, or even of vigorous intensity when done 'briskly'.

These uncertainties increased when further, imprecise descriptors such as 'levels' **(Haskell et al 1985 p 206, 209)** and 'modest' were introduced. Precision and clarity were reduced still further, when the two concepts were combined, without citation, by the 1992 statement on exercise from the American Heart Association: "Modest levels of physical activity are beneficial." **(AHA 1992 p 340).**

Even Paffenbarger's favoured concept of the 'volume' of exercise appears problematic. He defined volume in terms of total kcals of energy expenditure, but in so doing combined two distinct and different measures of activity: intensity and duration. **(Paffenbarger et al 1978)** The concept of total volume (kcals) of energy expenditure would be taken up by Blair **(Blair et al 1992)** and subsequently by other investigators committed to the new moderate intensity health 'paradigm'. But increasingly, Paffenbarger's own analysis of his volume data, would show that two components of volume, intensity and duration, were not entirely interchangeable. Those individuals who did strenuous or vigorous intensity activities (hence more intensity, at less duration) when total volume was held constant, enjoyed greater protection from cardiac disease and death **(Paffenbarger et al 1986, 1993 and Lee et al 1995)**.

Blair recently attributed imprecision in the discipline of physical activity to its newness, in comparison to not only the traditional medical disciplines, but also to its more commonly compared cousin, the study of nutrition. **(personal communication with SN Blair, London, November 2004)** Powell believed when he wrote his 1987 review **(Powell et al 1987)** that the discipline lacked rigour of measurement and added recently:

"Yes, it lacked precision then and it remains so. They [the various investigators] were not talking to each other enough. The other part of the problem is that physical activity is not a unitary thing like smoking where you can count the cigarettes. We struggle with the doses we've got: frequency, duration, intensity, method of activity. When put altogether they are very difficult to measure." **(personal communication with KE Powell, Atlanta, Georgia May 2007)**

Nevertheless, for a young and small discipline, such as the medical and public health study of physical activity, which was striving for greater recognition, and avowedly had put great value on the scientific and replicable measurement of 'dose – response', its collective work seemed to lack rigour and precision. Blair, himself, observed:

"I can't find anywhere in the literature well done studies of sufficient size of randomized designs when total volume has been clamped and then people have exercised at different intensities, I mean that's the study that needs to be done...and that study hasn't been done." **(interview with SN Blair November 2004)**

10.3.4 Summary of the three areas of 'uncertainty' and 'ambiguity'

Morris' 'brisk walk', as Powell observed, lost some speed when it crossed the Atlantic. It also lost precision – ranging from 3 to 4 mph, a considerable difference in both kcal energy expenditure/min and intensity. The explicit explanation for these differences appears to have been that the American investigators, led by Paffenbarger and Blair, claimed to be primarily uninterested in intensity of activity – and thus a reduction in speed, they asserted, could simply be made up (identically) by increasing duration. The implicit explanation may also have been that they doubted whether their target population, sedentary Americans, could comfortably exercise at Morris' higher (>4 mph) prescription.

The cohort differences (Morris' fitter British civil servants versus the American cohorts of Paffenbarger and Blair) may help explain, as Morris suggested, why he saw significant heart attack mortality reduction only from more vigorous (or 'moderately vigorous') activity, while the American investigators did not.

Given that the very early and continuing, US Government funded *Framingham Heart Study* included women in its cohort from the outset, it is hard to understand why no large scale longitudinal physical activity study included women until Blair's work published in 1989. Some explanation may be found in the greater earning power of men, their greater susceptibility to heart disease (than pre-menopausal women), the occupational roots of physical activity study, and the greater longevity of women.

Finally, 'loose terms' of physical activity dose (such as 'low', 'amount', 'modest' and 'level') hampered transparent comparison between studies, as Powell, himself, observed. The explicit explanation may lie, as he suggested, in the sheer complexity of measuring physical activity 'dose'. The implicit explanation, however, may lie in the fact that the core American investigators, led by Blair, were eager to dismiss (and to 'falsify') the importance of energy expenditure intensity, and were thus less eager precisely to define, use and record the exact measures of dose (intensity, duration and frequency.)

Finally, the use of 'loose terms' even featured prominently in the (apparently carefully scripted) preamble of the US Surgeon General's Report where the CDC director Dr David Satcher chose to speak vaguely about 'amounts' of physical activity, while the

Acting Surgeon General, Dr Audrey Manley, opted for the equally vague term 'levels'.
(USSG 1996 pp iii and v)

10.4 The Two Areas of 'Anomaly'

10.4.1 Did the unique role of the American Heart Association influence the drive to shift emphasis from vigorous to moderate intensity activities and did it also lead to focus on heart disease in the US Surgeon General's 1996 Report, to the disproportionate neglect of other health outcomes?

In the five years preceding the US Surgeon General's report, the American Heart Association produced at least four major statements and reports on physical activity and heart disease, (AHA 1990, 1992, 1993, 1995) and a fifth was published just as the 1996 Olympic Games was getting underway in Atlanta. This was a prodigious output – far greater than any other organisation concerned not just with heart disease, but with all health outcomes where physical activity might be perceived to play a beneficial role. Even though the US Surgeon General's Report ostensibly was to cover the impact of physical activity on all major disease outcomes, from cancer and diabetes, to obesity, osteoporosis and mental health – no other health/disease charity, or campaign/lobby group – was given any important representation among those listed as having planned, written and/or edited the Report. Dr Terry Bazzarre, the AHA's senior scientist for nutrition and physical activity, served on the Report's 11 strong Planning Board – which also included the influential investigators, Steven Blair and Russell Pate.

In some respects the evidently special status which the American Heart Association had in governmental policy making on physical activity seems entirely understandable. Heart disease was (and remains) the single biggest cause of death in the United States and the rest of the Western World. As early as 1967 physical inactivity had been identified by the US Government's ground breaking *Framingham Heart Study* as one of the five main risk factors for heart disease (blood pressure, cholesterol, smoking and obesity) **(Kannel WB 1967)**. Many of the most important findings to emerge from the Study were first published in *Circulation*, the house journal of the American Heart Association.

Ken Powell, who set up the first physical activity unit (BEEB) at the Centers for Disease Control and Prevention (CDC) saw the links between government and the AHA as

entirely appropriate, given his unit's small resources and the relatively weak evidence, at the time, that physical activity could be linked positively with illnesses and conditions other than heart disease:

"I think one could always make a connection, and many did, between physical activity and overweight from an energy-in – energy-out concept. But I don't think the emphasis on CVD was poorly placed....I mean we only had four people in this unit and so were not going to mount huge investigations into umpteen outcomes, especially when, as far as we could tell, the only [disease] with much supportive evidence [linking it to physical activity] was CVD. When you put that together with the fact that CVD is the single largest cause of death in the United States, it made a lot of sense to us that we should focus on it. Besides, no one else was thinking along those lines [that physical activity was protective] except the cardiologists."

(personal communication with KE Powell, Atlanta, Georgia May 2007)

Thus, the growing alliance between Powell at CDC and the American Heart Association worked 'reflexively' – or symbiotically to each other's advantage. The prestige of his association with the AHA gave Powell's small physical activity unit (BEEB) greater influence and authority within CDC than it might otherwise have done in competition with much more established divisions such as infectious disease control and smoking cessation. At the same time, by gaining access to shaping of the US Surgeon General's 1996 Report, the AHA could help to ensure that the Report's coverage of the cardiovascular diseases and its recommended guidelines for physical activity were in accord with the AHA's own thinking. And who was playing an increasingly prominent role at the AHA in shaping its physical activity policy? As we have seen, the outside 'expert' it learnt to rely upon most was Steven Blair.

10.4.1.1 The Cholesterol Hypothesis: a parallel

The AHA had, only a few years previously, played a very similar and influential role in the nutrition debate -- in what Karin Garrety has described as the "cholesterol hypothesis". **(Garrety K 1997)** This was the widely held, but unproven, belief that a reduction in the dietary consumption of saturated fat and cholesterol could causally improve blood cholesterol levels and bring about a significant reduction in the rate of atherosclerotic heart disease.

The cardiologists who dominated AHA policy making were at first, during the 1950s, cautious about embracing yet another nutritional proposition that might not stand up to

sound scientific scrutiny, and indeed, which might even reside in the realms of “food faddism and quackery”. **(Garrety K 1997 op cit on line)**

The hypothesis’ leading exponent was Ancel Keys, a nutritionist from the University of Minnesota, mentioned earlier in Chapters 2 and 4. Keys was not a physician, but held two PhDs, one of which was curiously in oceanography (University of California at Berkeley 1930) and the second in physiology earned at the Cambridge University in 1938 **(Centers for Disease Control and Prevention 1999a MMWR p 651)** Keys knew he needed to win over the medical establishment to his dietary theory, and, according to Garrety, the cardiologists at the AHA were his prime target:

“In 1960 Ancel Keys and another important interventionist, Jeremiah Stamler, ‘enrolled and translated’ their way into powerful positions within the AHA.” **(Garrety K 1997 on line)**

As Garrety explained, scientists without a sufficient powerbase, might seek to gain entrance to powerful bodies to enhance their own reputations, and in turn, the credibility of their hypotheses – a process which Karin Garrety has described as to ‘enrol and translate’ themselves and their scientific claims into positions of power and influence. **(op cit on line)**

After Keys and Stamler had gained influence at the AHA, the National Heart Lung and Blood Institute of the NIH commissioned two extensive clinical trials in the 1970s to test the cholesterol hypothesis. Garrety argued that the designs, results and interpretations of both studies were deeply flawed and that confirmation of the hypothesis remained elusive. Nevertheless, despite the uncertainty of the scientific evidence, the AHA decided to switch its stance and firmly backed the cholesterol hypothesis wholeheartedly, once Keys and other ‘interventionists’ had gained influence within the organisation. A July 1984 policy statement from the AHA published in *Circulation*, the journal of the AHA, commented shortly after completion of the second trial: “The huge burden of CHD does not permit awaiting definitive proof of the efficacy of the suggested modification in life style.” **(Kannel et al 1984)**

The rapid growth in the importance of the AHA in influencing post war US public health policy should not be underestimated. This power and influence emerged as infectious diseases came under greater control, while the incidence of cases of heart disease soared. **(Beaglehole et al 1993 p 84) (Centers for Disease Control and Prevention WWMR 1999b pp 649-50)** According to a report in the *Journal of the American*

Medical Association (JAMA) in 1945, the amount raised from voluntary funding for each case of infantile paralysis in the previous year was \$94, for tuberculosis \$22, for cancer \$8, and for heart disease just 3 cents. **(JAMA 1945 p 1037)** According to Garrety, “....entrepreneurs from the American Heart Association set about changing this situation” with an extraordinary public relations and fund raising drive. **(Garrety K 1997 on line)** The AHA voted in 1946 to become a national voluntary public health agency and was rapidly to become the most successful and influential medical fund raising charity, overtaking all other disease based rivals. **(Shephard WP 1950 p 740)**

Thus, by the 1970s the AHA's influence in public health issues relating to the cardiovascular diseases was powerful. The question raised, therefore, by Garrety was:

“Given the ambiguity of the cholesterol hypothesis boundary object, why did so many people come to believe that heart disease could be prevented by dietary change?” **(Garrety K 1997 online)**

Thus, by winning the endorsement of the AHA in the 1960s, Keys would effectively transform the cholesterol hypothesis from an appealing theory to an established and ‘scientifically warranted’ (if still unproven) fact.

With this question about ‘the cholesterol debate’ in mind, it might therefore begin to become clearer why the AHA only began in 1990 to take a higher profile in the emerging public health physical activity debate, an area which, like dietary intervention, might have been regarded as unscientific and beneath its more lofty medical concern. The AHA's 1990 position statement was ambivalent on the recommended intensity of activities. The AHA appeared uncertain whether to stick to the ‘vigorous intensity’ guidelines as previously devised by the American College of Sports Medicine (whose members were mostly exercise physiologists and not physicians), or whether to embrace the new ‘moderate intensity’ position that was then emerging.

However, just two years later, the AHA had swung firmly into the ‘moderate intensity’ camp, just as it had swung swiftly in the cholesterol debate. **(AHA 1992)** As previously observed, two authors of this new position statement were invited in from outside of the cardiology/medical establishment. Like Ancel Keys they were not physicians. They were exercise physiologists, Steven Blair and Carl Caspersen, who were both emerging as prominent advocates of the new moderate intensity position. They too knew the importance of winning over the AHA. **(personal communication with SN Blair, London, September 2006)**

Tony Bazzarre, the AHA's senior scientist for nutrition and physical activity, was the man who brought them in. He said:

"I was new to the Heart Association, and my interest was in nutrition and physical activity and I wanted to leverage the work of people I knew...I was lucky enough to be at the right time in the right place...I needed to have the best scientist available. I just knew that Steve's [Blair] work deserved recognition and that was a role and opportunity that I had." **(personal communication with TL Bazzarre, Princeton New Jersey, May 2007)**

As Garrety observed of Keys and Stamler:

"Although they were more radical than some of their colleagues, Keys and Stamler managed to acquire influential positions within the AHA. They could by no means be labelled as 'quacks'." **(Garrety K 1997)**

Exactly the same could be said of Blair and of Carl Caspersen, who was deputy to Ken Powell at the CDC.

Of course there are substantial differences between Garrety's cholesterol hypothesis narrative and the physical activity narrative that concerns this dissertation. The most obvious and important being that powerful commercial ('external' macro-economic) forces, namely the dairy/meat (saturated fat) and margarine/oils (unsaturated fat) industries, vied to exert influence over the cholesterol debate, as Garrety made clear. The non-saturated margarine/oils industries championed interventionists like Keys, while the sceptics were supported by the dairy/meat industries which initially feared that they had much to lose if the public eschewed saturated fats and cut consumption of their products.

Whereas, after careful scrutiny, no important evidence has been indicated that ('external' macro-economic) commercial forces were interested in, and were attempting to influence the physical activity debate, at least during the period (1948 – 1996) under consideration.

All the more importance must be placed, therefore, on examining the less obvious (non-economic) social levers which may therefore have influenced the outcome of the transformation of the public health guidelines from focus on 'vigorous threshold' to 'moderate intensity and total volume (kcal)' physical activity.

The two narratives do, however, appear to share several important features. First, and foremost, they both took place in the public health sphere of Regulatory Science. Second, they both focused, primarily at least, on the prevention of cardiovascular disease. Third, as Garrety and this author have both argued, given the uncertainty and ambiguity of the science in each case, why did so many people come to believe that each intervention (reduced consumption of dietary cholesterol and adherence to leisure-time moderate intensity physical activity) would be effective in significantly reducing heart disease?

In both narratives the crucial explanatory factor appears to have been in the disproportionate (and thus anomalous) influence of a small, but influential and well meaning group of investigators. Blair and his close colleagues convinced themselves that the new moderate intensity health 'paradigm' was based on sufficient evidence that it should replace the old 'vigorous threshold' hypothesis. They set out to influence, and then dominate the key public health forums (CDC/ACSM, AHA, NIH and USSG 1996) that would implement this new public health policy. Their apparent motives included, first to improve the public health and second to enhance the reputation of physical activity science policy within the public health arena. Blair, in particular, was proud of being the most persuasive and high profile advocate of the new health 'paradigm'. **(personal communication with SN Blair, London, October 2007)**

Many people hope that they can take simple, palatable steps to improve their own chances of good health and to avoid disease and to postpone their death. As a simple, self-help method, Garrety's description of dietary fat intervention accords with that of moderate physical activity: As she said: "The concept has an appealing simplicity which facilitates its wide circulation" **(Garrety K 1997 on line)**.

Similarly, the moderates, led by Blair and Powell, benefited from the influence of the AHA both to endorse their new moderate-intensity health 'paradigm' and to raise the public health profile of physical activity itself, as an important protector not only against heart disease but against other diseases and conditions for which the evidence was less developed and less robust. With the AHA's support they were able to convince the Secretary of State at the US Department of Health and Human Services to commission the *US Surgeon General's Report on Physical Activity and Health 1996*. In turn, and reflexively, the AHA hoped to direct that report toward focus more fully and firmly on

cardiovascular disease – thus giving an even higher public health profile to prevention strategies to reduce the incidence of cardiovascular diseases.

10.4.2 Did Steven Blair lead a small and cohesive group of investigators in gaining exceptional access and influence within the important conferences and workshops that shaped and promulgated public health policy on physical activity? Whether they were, in part, motivated by a desire to ensure physical activity played a more prominent role in US public health policy, did they also have a desire to enhance their own personal and academic reputations?

A single investigator, Steven Blair, appears to have played a highly influential role in convincing the American Heart Association and the US Government to switch the primary focus of public health recommendations for physical activity from vigorous to moderate intensity exercise. This influence was greater than (and therefore disproportionate to) the nonetheless substantial scientific evidence that he generated and was additionally enhanced by the personal and social skills which he employed successfully to win consensus support for the moderate ‘physical activity-health paradigm’ (**Pate et al 1995 p 405**) within his profession. He then successfully used that support and his own social skills to become an influential member of the key forums which preceded the US Surgeon General’s Report. Finally, he succeeded in being appointed the ‘senior scientific editor’ of the Report itself, ensuring that he would play a central role in the public policy it promulgated.

10.4.2.1 Background to Steven Blair’s Rise to Positions of Influence

The early epidemiologists, Morris and Paffenbarger, were physicians (MDs) with considerable knowledge of, and interest in public health. Blair, by contrast, had planned to be an athletics coach and went on to earn a doctorate in physical education (P.E.D), with interests in exercise physiology and epidemiology. (**personal communication with SN Blair, London, October 2007**) Most of Morris’ and Paffenbarger’s careers were spent at universities (The London School of Hygiene and Tropical Medicine and Stanford, respectively). While Blair recently moved to the University of South Carolina (in 2007), most of his career was spent at the Cooper Institute, a “nonprofit, tax exempt public corporation” established by his mentor, Dr Kenneth Cooper to promote the value of physical activity in health promotion and disease prevention. (**Cooper Institute home page website**). It was under Cooper that he began his core epidemiologic investigation, the Aerobics Center Longitudinal Study (ACLS).

According to Medline (PubMed), Blair published or co-authored around 98 papers between the start of his publishing career in 1974 and publication of the US Surgeon General's Report in 1996. Prior to the late 1980s most of his articles appeared in journals specialising in exercise physiology and sports medicine such as *Research Quarterly for Exercise and Sport*, and *Medicine & Science in Sports & Exercise*. However, in this period at least four articles authored by him were published in journals of wider scope (*Journal of the American Medical Association (JAMA)* and *Circulation*), although most frequently (3 of the 4) they appeared with his mentor, Dr Cooper, as a co-author.

10.4.2.2 Aerobics Center Longitudinal Study: Blair et al 1989

Blair was an invited participant and co-authored a paper at the seminal physical activity and public health workshop in 1984 organised by Kenneth Powell (**Powell and Paffenbarger 1985**). However, his contribution was relatively modest. It is difficult to over estimate, therefore, the sudden impact and subsequent longer term importance of his 1989 study which he very much led, and which examined by treadmill test the impact of physical fitness on all-cause mortality among more than 13,000 men and women. (**Blair et al 1989**) As has already been noted, its publication in the *Journal of the American Medical Association (JAMA)*, with an accompanying editorial comment from the Centers For Disease Control and Prevention (CDC), became the basis for the front page lead article in the New York Times on the same day in November 1989. (**Hilts PJ NYT 1989**) Its key conclusion, that only a small improvement in fitness brought a great reduction in mortality, while further improvements showed only modest gains, conflicted with and confounded the previous, and themselves conflicting models or hypotheses (threshold intensity, linear total volume) of the 'dose-response' of physical activity upon health, disease and death. Not only did the result surprise other investigators, but Blair also claimed to be surprised, himself:

"I was involved in the [earlier public health] guidelines which stressed vigorous activity. I didn't say I am going to start a movement to change this. [But] what really changed my thinking was my 1989 paper.... These people who get out of the low fit groups and were moderately fit, they had so much lower death rates." (**personal communication with SN Blair, London, November 2004**)

The 1989 paper began to be cited in other influential publications as soon as it appeared and continues to be cited frequently. For example between 2004 and August 2009 it was listed in the archives of JAMA as having been cited in 95 separate

publications. More important even than the frequency of references to it, the 1989 paper became the bench mark study upon which the moderate 'physical activity-health paradigm' was built. **(Pate et al 1995 p 405)** Blair and Pate were leading members of the 'planning committee' and members of the consensus panel, that proposed this 'paradigm' hypothesis at the 1995 CDC/ACSM conference which, itself, appears heavily to have influenced both the NIH Consensus Panel Conference in 1995 **(NIH 1996)** (where both men again played influential roles) and the US Surgeon General's Report, of which Blair was the senior scientific editor.

Indeed, beginning in 1992, Blair appears to have been appointed to every influential conference, panel and workshop on physical activity and health in the critical years approaching the Report's publication. As Garrety has shown (see above) Ancel Key's success in getting into the policy process at the American Heart Association was crucial in popularising his 'cholesterol hypothesis'. Blair appears to have been even more widely successful than Keys in the way he 'enrolled and translated' his way into powerful positions within the AHA **(Garrety K 1997)**, and beyond to ensure the popularity and success of the 'moderate intensity-total volume hypothesis'. These 'enrolments' included:

1992 AHA *Statement on Exercise* (co-author)

1993 AHA Prevention Conference. *Physical Inactivity Workshop V* (chair)

1994 AHA *Strategic Plan for Promoting Physical Activity* (chair)

1995 CDC/ACSM Physical Activity and Public Health Conference (planning committee and consensus panel)

1995-96 NIH (NHLBI) *Consensus Development Panel Physical Activity and Cardiovascular Health* (planning committee and speaker)

1996 AHA *Statement on Exercise* (co-author)

1996 *US Surgeon General Report on Physical Activity and Health* (Senior Scientific Editor and Planning Board)

This is not to suggest that Blair was alone in playing a prominent role in changing the physical activity guidelines, but simply that his presence was all but ubiquitous. For example, Blair's colleague and collaborator, Russell Pate was, of course, the lead author and on the planning committee of the 1995 CDC/ACSM panel and report **(Pate et al 1995)**. Pate was also, with Blair, on the planning committee and a speaker at the

1995-6 NIH consensus panel and report (**NIH 1996**), and on the Planning Board of the US Surgeon General Report. (**USSG 1996**) But he did not yet play a prominent role at the American Heart Association. Another prominent figure was Carl Caspersen, Kenneth Powell's deputy at the CDC, who, along with Blair, was an outside co-author of the pivotal 1992 AHA Statement on Exercise. He was also extensively involved with both the NIH consensus panel and report and the US Surgeon General's report. Indeed, it was Caspersen who first introduced Blair to Powell in 1984. (**personal communication with KE Powell, Atlanta, Georgia, May 2007**). Blair, Pate and Caspersen were, of course, close friends and scientific colleagues.

In addition to his academic output, Blair has also written several successful get-fit-stay-fit books for the lay public. Powell argues that Blair combines a passion for his work with the popular touch. But did these attributes influence his primary scientific work as an exercise physiologist and policy maker?

"I think Steve is very important. He may have been our best advocate and ambassador. He comes from a scientific background and for the most part Steve is very concerned about that. He does good scientific work and wants his papers to be correct. But he is very willing to put on the advocacy hat. When a scientist does that, if he's going to be an effective advocate, he'll behave differently, and he'll say things differently. He'll emphasise some things, and he won't mention other things...because that's what advocacy is. An advocate is somewhat like a cheerleader. Now some advocates and cheerleaders are charlatans. Others, and I think Steve is one of them, are very passionate and his interest in doing that is all for the public good....We can really improve the public health of the people and I think Steve feels strongly about that." (**personal communication with KE Powell, Atlanta, Georgia May 2007**)

Blair's relationship with Adele Franks may also shed some insight about his influence in shaping public health policy in this field. Dr Franks, who was Assistant Director for Science at the CDC, is a physician (MD) who had no special interest or expertise in the field of physical activity. She was chosen, however, to become the scientific editor of the US Surgeon General's 1996 Report (along side Blair) when its publication was threatened by internal divisions – and most notably over the attempt, as she saw it, by some advocates to push the moderate intensity 'paradigm' beyond the scientific evidence underpinning it:

“My job was to fix this report and get it out on time, and Steve’s job was to work with me. We were going to work as a team because Steve Blair had all the political capital in the field, knowing all the investigators, everybody liked him. He was one of them. So if I could work with him, then hopefully he could repair the damage and ill feeling by telling the field ‘we have to do it Adele’s way’ and to try to make it palatable to them. Otherwise they would have been in a complete revolt...they being Pate, Haskell, Sallis and the bunch...Steve would accept 90% of it [my changes] but then he would say, no we have to keep that [and I did].” **(personal communication with A Franks, Northampton Massachusetts, May 2007)**

10.5 Chapter 10 Summary and Conclusions

In the 1980s a group of American investigators began to question the ‘vigorous threshold intensity’ hypothesis first formally elucidated by Morris in 1973. **(Morris et al 1973)** Their primary motivation was to promote public health by increasing the physical activity of a largely sedentary American population. To that end they sought a new ‘exercise prescription’ that would: bring physical activity fully into the public health arena, prove effective in protecting against cardiovascular disease and other health outcomes, and inspire greater long-term adherence, especially among the growing sedentary portion of the population.

They began by attempting to ‘falsify’ the vigorous intensity hypothesis, while searching for evidence to support their new moderate “physical activity-health paradigm”. **(Pate et al 1995 p 405)** This search focused on what they described as the ‘dose-response’ of physical activity to health protection/improvement and disease prevention. It was hampered, however, by large gaps in the knowledge base that would, from both a clinical and public health perspective, need to be considered. Most important were inadequate data for, and measurement of, the intensity of activities and their impact upon cardiovascular disease in middle aged, and largely middle class white males. Evidence regarding this ‘dose-response’ among other populations (women, children, the elderly, ethnic minorities and the poor) and about other health outcomes (cancer, diabetes, obesity) was very much weaker still.

Nevertheless, ‘the moderates’ sought to falsify the vigorous intensity hypothesis, and the existing 3 x 20min/wk guidelines, on two main grounds: that such intensity was not necessary to achieve significant cardiovascular protection in all, and especially

sedentary populations, and that 'misperceptions' about the need for intensity to be vigorous were deterring many Americans from exercise adherence. At the same time, they sought, with little visible evidence, repeatedly to assert the greater likelihood of adherence to moderate intensity activity that new (5 x 30min/wk) public health guidelines would attract – even though existing evidence from behavioural surveys consistently showed that a perceived lack of time was the most common deterrent to leisure time physical activity (LTPA). They sought further to show that the health benefits of moderate intensity activities had been under-explored and underestimated.

While these investigators largely succeeded in falsifying (at least among American populations) the concept that a minimum intensity threshold existed below which no significant health improvements could be achieved, they largely failed to demonstrate that intensity of activity was of no clinical importance and/or that moderate intensity activities were the same, or very similar in clinical benefit as more vigorous activities. Further, they largely failed to provide verifiable evidence for a virtually opposite theory that health improvements were 'concave curvilinear' – that is, almost all gains could be achieved with a small improvement in cardiorespiratory fitness, and that very little more was accomplished from higher levels of fitness most often associated with vigorous intensity activity. To the contrary, most rigorously conducted studies broadly concluded that the 'dose-response' gradient of physical activity was – as might logically be predicted – linear within limits of intensity, duration and frequency. **(Paffenbarger et al 1978, 1986, 1993 Ekelund et al 1988, Morris 1990, Sandvik et al 1993, Lakka et al 1994, Lee et al 1995)** They also failed to find substantial evidence to support their 'common sense' supposition that moderate intensity activity would inspire greater long term adherence, even though the guideline time to achieve it was at least 2 ½ hrs a week in duration (5 X 30 mins), and 1 ½ hrs a week longer than the existing vigorous intensity recommendation (3 X 20 mins).

Nevertheless, this group of investigators, led by Steven Blair successfully achieved their goal of changing the bench mark public health advice, first in the United States, and then throughout the developed world from a shorter, vigorous intensity prescription to a longer, moderate intensity one. The success was based on at least 3 interlocking factors. First Blair's 1989 paper **(Blair et al 1989)**, which elucidated the strong 'concave curvilinear hypothesis', captured not only academic and popular headlines, but it also encapsulated the exceedingly appealing notion, little short of biological 'activity alchemy', that a most modest, and relatively painless improvement in fitness would add years of healthy longevity, especially to even the most unfit

Americans. The extreme asymptotic curve of its mortality data has, to this author's knowledge, never been closely replicated other than in a very unfit population chosen specifically for its extremely high risk of acute cardiovascular disease, **(Leon et al 1987)**

Second, the new moderate health 'paradigm' was, after initial caution, broadly endorsed by the American Heart Association. The AHA was highly influential in ensuring that both the National Heart, Lung and Blood Institute of the NIH, and the US Surgeon General's Office would effectively make the new moderate activity guidelines official US public health policy.

Third, Steven Blair was extremely successful first in securing a highly influential role at the AHA, and then in using this influence to secure key roles in production of both the CDC/ACSM 'expert panel' report on *Physical Activity and Public Health* **(Pate et al 1995)** and the NIH consensus paper on *Physical Activity and Cardiovascular Health*. Most notably of all he was successful in becoming the senior scientific editor of the US Surgeon General's seminal 1996 report on *Physical Activity and Health*.

Chapter 11: Conclusion

11.1 Primary Conclusions

For more than a decade, the US Surgeon General's 1996 Report and its central recommendations became the benchmark for physical activity and public health in the United States and throughout much of the Western world.

It gave 'warranted authority' to the unproven 'moderate/volume' hypothesis espoused by Blair and his colleagues, while effectively discarding the evidence that the 'rate' or intensity of activity was of substantial importance in maximising, or even achieving, cardiovascular and other health benefits.

The Report also claimed that 'an emerging consensus' of expert scientific opinion had formed to demonstrate that physical activity need not be vigorous to bring health benefits. Of course, in a narrow sense, this had always been true. When Morris, in his landmark study, first compared the heart attack death rates of London bus conductors with their driver counterparts in 1953, he merely compared 'moderate' activity (double-decker stair climbing) to the sedentary inactivity of sitting behind the driver's wheel. Twenty years later, when he embarked on his equally ground-breaking leisure time physical activity study, Morris did not expect that a 'minimum threshold' of intensity of activity (≥ 7.5 kcal/min) would be necessary significantly to reduce heart attack/death risk.

Evidence supporting that 'minimum threshold' effect was only rarely replicated in the United States, most notably when Paffenbarger and Lee could see no significant reduction in all-cause mortality if 'strenuous sports play' was stripped out of the total volume of other physical activity in their *Harvard Alumni Study* (Lee et al 1995).

Furthermore, Blair and his colleagues, like Morris himself, saw evidence that moderate activity and/or fitness alone might prove significant in improving health outcomes among individuals who were older or fundamentally less fit and from very sedentary populations. Hence moderate activity might 'work' for an American population that was becoming increasingly unfit as manual labour was reduced and most people adopted leisure lifestyles that saw little or no physical activity. However, a moderate activity recommendation might equally be hampered because of the greater duration and frequency of its application that might deter adherence in population terms.

As has been documented, Morris himself saw a significant (albeit reduced) increase in heart attack/death protection at below his 'minimum threshold', most notably in his

1990 study among older members of his male British civil servant cohort (**Morris et al 1990**)

While the ‘minimum threshold’ effect was frequently not in evidence, more commonly a direct and linear ‘dose-response’ was observed with increasing intensity of activity/and or fitness, not least by Haskell and colleagues (**Ekelund et al 1988**) and Vuori and colleagues. (**Haapanen et al 1996**) Thus, Morris’ broad hypothesis, and the accepted wisdom of exercise physiologists of the day: that intensity of activity was important, not only in improving cardiorespiratory performance, but also in health outcomes, had not been falsified.

Admittedly, given the discipline’s roots in exercise physiology and elite athlete training, it is not surprising that the value of moderate activities, particularly in relation to sedentary inactivity had been inadequately, and too infrequently studied. A desire by investigators and policy makers, therefore, further to examine the value of moderate amounts (kcal/wk) of moderate intensity activity – particularly for sedentary people with very inactive lifestyles, seems in public health terms to be both understandable and laudable. What seems less defensible were the steps taken by investigators and policy makers, whether consciously or unconsciously, implicitly or explicitly, selectively to interpret the scientific evidence base, so as to minimise consistently both the value and acceptability of vigorous intensity activity and to overstate the benefits of moderate physical activity.

11.1.1 Selective Interpretation and Macro-economic Influence within Regulatory Science

Such selective interpretation of evidence is common in highly contested areas of ‘Regulatory Science’, as many authors, not least Carson, Jasanoff and Nestle have shown. (**Carson R 1962, Jasanoff S 1987 and 1990, Nestle M 1993**) Most often, however, the causes of such influences are ‘external’ and ‘macro-economic’. In the case of the public health - physical activity debate however, the distortions arose internally and the primary motives were not evidently financial. An examination of the published research support for the main investigators reveals very little commercial involvement. The only research grants declared by Steven Blair (**Blair et al 1989 and Blair et al 1996**) came from the US Public Health Service. Similarly, research by William Haskell’s team (**Ekelund et al 1988**) was declared to come only from the National Heart, Lung and Blood Institute (**NHLBI**) of the National Institutes of Health

(NIH). Ralph Paffenbarger's team investigation in 1986 (**Paffenbarger et al 1986**) also declared support from the NHLBI, although the study did unusually receive further support from the 'Marathon Oil Foundation' and the chemicals corporation, DuPont. However, this corporate funding did not apparently continue, since it was absent from his team's definitive study (**Lee et al 1995**) which declared support only from the NHLB, and the National Cancer Institute.

One might therefore question why no substantial 'macro-economic' forces were evidently in play in this public health debate within the realms of Regulatory Science? The first answer may simply be that the 'financial value' of the physical activity debate was insignificant compared, for example, with the battles fought, and still being fought, to control and/or restrict tobacco and alcohol use, or those constantly being waged in the field of nutrition and health – and no longer just primarily about the dietary causes of cardiovascular disease, but also about other outcomes, most notably cancer, and now also over the importance of the promotion of 'junk food' and 'super-sizing', for example, in increasing the 'obesity epidemic'. Yes, commercial gyms and even motor car manufacturers may benefit or lose from public health decisions which raise the profile of physical activity generally and, particularly, the advocacy say, of the relative merits of extremely inexpensive 'brisk walking' versus, bicycling, running, swimming, squash club membership or perhaps, weight training. But again, the sums involved, and the profits to be made, are comparatively modest now, and would have been much less obvious still to any commercial interests in the first half of the 1990s, before the increasing speed and power of the commercial and technological revolutions brought about by the wide spread use of personal computing and the Internet. Besides, and simply: no one very much cared (financially, medically or politically) about physical activity and health until the pioneers such as Morris and Paffenbarger, and Powell and Blair began their investigations and formed their alliances.

11.1.2 The 'Mertonian' Influences of Altruism and Fame in the Physical Activity Debate

Thus the 'distortions' in this debate arose primarily instead from an unusual mixture of what might be described, in Mertonian terms, as 'altruism and fame'. Without question, Morris, Paffenbarger, Powell, Haskell, Blair and other leading investigators and policy makers in the field were primarily driven by their eagerness to promote physical activity as a front-rank public health tool, believing that its importance in disease reduction and health improvement had been woefully undervalued. Whatever the final judgements may be, it seems clear that without their immense and sustained efforts, the public health importance of physical activity (at any intensity or duration) would not have risen

so high, and thus would not have been given the prominence, and long enduring importance of a US Surgeon General's Report. That alone is a most commendable achievement.

No doubt their own reputations, and those of their academic departments and institutions would have risen in parallel, and thus motives of 'fame' and to a lesser extent, financial reward, primarily through promotion and enhanced salaries, cannot be entirely discounted.

Certainly, there was evidence that too many, and an increasing number of American adults were sedentary and that far too few were regularly adhering to the prevailing 3x20 minutes/wk vigorous intensity recommendation. The idea that moderate activity was not only understudied, but that it might make a more palatable public health prescription, for both the American public, and policy makers and politicians, appears most clearly to have emerged from the 1984 *Workshop on Epidemiologic and Public Health Aspects of Physical Activity* organised by Powell and Paffenbarger, along with Haskell, Blair and Caspersen.

However, momentum for the 'moderate/volume' hypothesis first took shape only after publication in the *Journal of the American Medical Association (JAMA)* and on the front page of the *New York Times* of Blair's *Aerobics Center Longitudinal Study* in 1989 which appeared to indicate that the biggest risk reduction in all-cause mortality came between the least fit and next least fit quintiles with Blair declaring: "This finding has clinical and public health importance." (**Blair et al 1989 p 2400**)

To ensure the 'warranted authority' of this message Blair, like Ancel Keys before him, began rapidly 'to enrol and translate' his way into influential policy positions – first with the American Heart Association and subsequently with the two lead US Government agencies (Centers for Disease Control and Prevention and the National Institutes of Health) that were setting public health policies in physical activity. Finally, of course, he became the leading (senior scientific) editor of the US Surgeon General's Report itself, ensuring that the 'moderate/volume' concept, while toned down by co-editor, Adele Franks, would nevertheless be enshrined as official US government policy – even though, just like Keys' 'cholesterol hypothesis' it was highly contestable.

Systematically then, studies which favoured vigorous intensity physical activity were mis-interpreted, down played or even ignored, while those many fewer which appeared to favour more moderate intensity activities were highlighted and given prominence. As Winett observed in the *Journal of the American Medical Association (JAMA)*, while

these desires may have been “seemingly well intentioned....the public health message they deliver may be problematic and potentially counterproductive from both scientific and public policy perspectives.” **(Winett RA 1995 p 534)**

In summary, therefore, the answers to the central research questions (see Chapter 3 and Chapter 10) are, after consideration, these:

The decision by the authors and policy makers who drew up the US Surgeon General's 1996 Report to switch emphasis from vigorous to moderate intensity leisure-time physical activity (LTPA) was not based on sound and uncontested evidence alone. The scientific evidence, from both epidemiological studies and randomised controlled intervention trials at the time of the Report's formulation was conflicting, contested and often confusing. In fact, both 'external' and 'internal' social factors profoundly influenced, what was proclaimed by the Acting Surgeon General and the Secretary from Health and Human Services to be, a decision based purely upon an 'emerging consensus' of scientific evidence. The American Heart Association (AHA), which had, in its own guidelines, broadly endorsed vigorous intensity activity since the 1970s, began rapidly to switch support to the 'moderate-total volume' hypothesis in the early 1990s. This fundamental change in policy and external influence from the AHA coincided with the arrival of Steven Blair, a leading 'internal' investigator (albeit not from an academic department, but from the Cooper Institute) and an advocate of the new hypothesis, and his allies on committees and workshops on physical activity set up by the AHA. The AHA's 'external' influence would further extend to getting its own specialist on physical activity, Terry Bazzarre, on to the Report's planning committee – the only individual representing an external organisation afforded the privilege of working within the Report's core taskforce of writers and editors .

After 'enroling and translating' his way into influential positions at the AHA, Steven Blair went on successfully to use his scientific and medical standing to secure leading roles on the two 'expert consensus conferences' that took place in the immediate months before the Report's publication -- the first convened jointly by the Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM) **(Pate et al 1995)** and the second by the National Institutes of Health **(NIH 1996)**. Finally, Blair was appointed as the senior scientific editor of the Surgeon General's Report itself, ensuring that he would play the most influential role in its construction, content, and conclusions.

11.1.3 Postscript:

As a postscript, it should be noted that the ‘warranted authority’ of the moderate intensity hypothesis did not, at least in its unalloyed form, remain US public health policy for leisure time physical activity. With a great deal less fanfare than was presented in the opening political polemics of US Surgeon General’s Report on the eve of the 1996 Atlanta Olympic Games, the official US physical activity guidelines were substantially changed in the Autumn of 2008 with publication by the US Department of Health and Human Services of new *2008 Physical Activity Guidelines for Americans – (USDHSS 2008)* a document backed by an advisory committee report so detailed that it dwarfed even the US Surgeon General’s 1996 Report. **(USDHSS AC 2008)**

Many on the new report’s advisory committee had played important roles in previous major pronouncements including the US Surgeon General’s Report. These included William Haskell, its chairman, Kenneth Powell, Russell Pate and I-Min Lee, the primary collaborator of Ralph Paffenbarger, who had died. Steven Blair was not on the advisory committee, but was listed as a contributing consultant.

It is not within the scope of this dissertation to examine the document in detail nor to try to explain its social construction. However its authors did not suggest that evidence gleaned by investigators since 1996 had uncovered any important changes in the data base regarding the ‘dose-response’ profile of physical activity on health outcomes. Yet its primary message was fundamentally different both in tone and substance. Gone were any messianic messages about the ‘emerging consensus’ of the benefits of moderate ‘amounts’, ‘levels’ and ‘intensities’ of activity. For reasons unexplained, and without any new definitions given, the new report’s primary focus was on an intensity of activity which it described ambiguously as “moderate to vigorous”: It said:

“Reasonably strong evidence demonstrates that participating in moderate to vigorous physical activity for more than 150 minutes a week is associated with greater health benefits for a variety of health outcomes, including chronic disease prevention, improvement of various disease biomarkers, and maintenance of a healthy body weight.”**(op cit p 34 online or A-8)**

With some apparent reluctance, the new report seemed also to accept that vigorous intensity activity was superior to moderate intensity activity – but it held out the caveat that the sheer ‘volume’ of activity might still be the most significant factor:

“Strong evidence indicates that an increase in intensity is associated with greater improvements for some health outcomes compared to those observed with moderate-intensity activity. This is especially true of outcomes related to fitness. However, it should be noted that an increase in intensity was also associated with an increase in volume for many observational and experimental studies, and it is difficult to separate the benefits of each.” **(op cit p 34 online or A-8)**

However, from a public health perspective, the new report further acknowledged that busy Americans might prefer vigorous activities because they took less time:

“One time-efficient way to achieve greater fitness and health goals is to substitute vigorous-intensity aerobic activity for some moderate-intensity activity. Using the 2-to-1 rule of thumb, doing 150 minutes of vigorous-intensity aerobic activity a week provides about the same benefits as 300 minutes of moderate-intensity activity.” **(USDHSS 2008 p 25)**

But the new report still appeared to struggle with the conclusion that intensity of energy expenditure, rather than volume, was the most critical element of disease protection:

“In many of these outcomes, including cardiovascular morbidity and mortality, there appears to be a more favorable response with increasing intensity of exercise bouts, although exercise volume is poorly controlled in some studies and may be the important mediating exercise parameter. Also, the more powerful relation between exercise intensity and outcomes does not hold for all outcomes in experimental studies, especially when weekly volume or energy expenditure is held constant (160).” **(USDHSS 2008 AC p 193-194 online or G2-39-40)**

However, when that cited reference (160) is actually examined, the authors (Swain and Franklin) did not reach such a qualified conclusion, but said quite explicitly that vigorous intensity activities were more ‘cardioprotective’ than moderate intensity activities:

“In conclusion, if the total energy expenditure of exercise is held constant, exercise performed at a vigorous intensity appears to convey greater cardioprotective benefits than exercise of a moderate intensity.” **(Swain and Franklin 2006 p 141)**

Such an anomalous interpretation of the new report's own cited reference was not explained. Yet, it would seem, therefore, that Morris' resistance to a moderate intensity public health prescription had been justified. In conclusion, it is perhaps therefore fitting, to remember again Popper's observation that:

“Normal’ science, in Kuhn’s sense, exists. It is the activity of the non-revolutionary, or more precisely, the not-too-critical professional: of the science student who accepts the ruling dogma of the day; who does not wish to challenge it; and who accepts a new revolutionary theory only if almost everybody else is prepared to accept it – if it becomes fashionable, a kind of bandwagon effect. To resist a new fashion needs perhaps as much courage as was needed to bring it about.” **(Lakatos I and Musgrave A 1970 p 52).**

11.1.4 Final Observations

11.1.4.1 Theoretical Frame Work of Social Influences Drawn from Previous Authors

As was discussed earlier in Chapter 2, I have tried to create a ‘tool kit’ of concepts drawn from earlier authors which reflects how they identified and investigated the various social (non-scientific) influences which selectively changed the regulatory science process in the areas and case studies that they examined. A resumé of this theoretical frame work or ‘matrix’, and how it helped shape my own investigations, can also be seen in tabular form **(Table 10.1)** in the previous chapter, Chapter 10. It does not claim in any way to be exhaustive, or even comprehensive. Most certainly its scope and range could be expanded well beyond its 9 categories or ‘cells’. Nevertheless, this framework has, I believe, helped to conceptualise and organise this investigation, and to that extent I would hope that it might make the beginning of a theoretical contribution to the study of science policy, which may assist future investigators. To that extent, I feel that I have gone substantially further than just to replicate findings of prior studies. Indeed, with the the use of the ‘matrix’ devised with insights from the political Sociology of Scientific Knowledge (pSSL) and Actor-Network Theory, I have tried to improve the robustness of the wider analytical approach of Realist Constructivism. Moreover, just as Garrety’s work with Ancel Keys and its ‘realist’ approach within Actor-Network Theory enlightened and informed me, I would hope that this study, equipped with its theoretical ‘tool box’ drawn primarily from earlier authors, would help current and future science policy researchers to explore new approaches to investigations, especially those where more subtle, yet perhaps more persuasive and effective social influences prevail, which are not obviously, ‘external’ or ‘macro economic’ – in the vernacular

where they derive from purposes which are not overtly, and primarily in the pursuit of financial gain.

When I began this examination, I must admit that I relied, no doubt too heavily, on my background in investigative journalism to inform my search for any 'social influences' that may have distorted the late 20th century physical activity and health debate. To that extent, my 'radar' went primarily in search for those 'macro economic' forces so often at work in regulatory battles over public health. It was not until I succeeded in constructing, and then attempted to use the range of conceptual 'tools within the matrix box', that a clearer picture of influence derived, not primarily from money, but from 'altruism and fame' began finally to emerge and take clearer shape. I found this outcome not just personally rewarding, but, perhaps in some way, important to the future examination of the sociological study of science. I would hope, therefore, that future authors in related fields will find this concept of drawing together a wide range of social influences valuable enough to wish to build upon it, and to improve upon it.

11.1.4.2 General Lessons

It is never easy to measure accurately whether any public health nostrum, no matter how sound its science and skilled its promulgation, can substantially alter public perception and then behaviour in any selected population. We probably cannot judge, therefore, whether the new 1996 'moderate' US physical activity guidelines succeeded in getting more Americans (and other people in Western developed countries) to become more physically active and to discard sedentary habits – or if not halted, at least slowed the advance of sloth. As a general lesson however, if Winett's observations were correct (**Winett RA 1995 and Winett and Carpinelli 2000**) this and other important public health goals might more successfully have been approached had the science underpinning, in this case, the role of physical activity in human health, been more accurately followed – and distorted less by non-scientific influences. Health benefits should perhaps not be exaggerated just because they appear plausible and populist. Surely, this was a lesson that should have been learned from earlier attempts at first to reduce the ravages of smoking by urging people 'to cut down' or switch or to 'filtered' and then 'low-tar filtered' cigarette brands – rather than to urge them to stop smoking altogether, and latterly to ban smoking in all public places.

Of course, the tobacco debate was, and remains heavily influenced by the lobbying strength of the tobacco companies themselves. As a further general lesson, this examination of physical activity public health guidelines should remind not just policy makers, but also scholars that not all such science policy based debates (and unlike

tobacco, alcohol, and food) are constructed primarily by 'external' and 'macro-economic' forces. In this case, the influences arose from factors that could be categorised as primarily 'internal' among the scientific investigators and the public health policy makers and politicians.

Policy makers in public health may hopefully benefit particularly from examination of the 'non-financial' social influences explored in this study – not least because the 'emerging scientific consensus' in favour of moderate intensity guidelines, so vividly proclaimed by policy makers in the preamble of the US Surgeon General's 1996 Report, was so rapidly and comprehensively revised (and the greater benefits of vigorous activity largely re-instated) just 12 years later in the *2008 Physical Activity Guidelines for Americans*. This 'emerging consensus', therefore, appears to have built more on wishful thinking than on the 'warranted authority' of robust, uncontested scientific evidence. Unfortunately, this later and even more comprehensive report did not enjoy the same publicity and recognition of the Surgeon General's Report published on the eve of the 1996 Atlanta Summer Olympic Games when American interest in sport and physical activity was high. To the contrary, the 2008 guidelines were published in October – in what would be the last dying months of the then discredited George W Bush presidency. Further, the new Democratic President, Barack Obama, while a keen sportsman himself (basketball and golf), immediately focused his primary health intention, not on physical activity and public health, but on the intensely political and hugely 'macro-economic' battle over healthcare reform.

11.1.4.3 Analytical and Methodological Utility and Limitations

Initial expectations and theoretical inclinations to use solely a Realist Constructivist analytical approach were changed during the course of this project as it became increasingly clear that the direct importance and wider influence of Steven Blair and his close circle would also require recognition and use of a 'realist' interpretation of an Actor-Network Theory approach, which is not dissimilar from Garrety's (**Garrety K 1997**), because the social influences at work were very much 'internal' to this small group of scientific investigators and policy makers.

While I was fortunate, I believe, to have been able to interview all of the central protagonists in this study, limited funds meant that I was unable to seek further interviews with all the American investigators and policy makers that I would have wished, and this was a important limitation in my methodology and one which would have been even more hampering if Steven Blair had not been so generous with his

time on three separate occasions when he visited England, and through numerous email exchanges. A further important limitation was failure to illicit any background and unpublished 'grey' matter from the deliberations and communications of the US Surgeon General's selected taskforce, although I take on good faith that all of these items were discarded and destroyed when the when the nutrition and physical activity division was subsequently created at the Centers for Disease Control and Prevention (CDC).

11.1.4.4_Suggestions for Further Research

Initially, this dissertation was conceived to examine not only the historical construction of post-World War II US physical activity guidelines in relation to cardiovascular diseases – but also equally to examine whether and why the 1996 guidelines gave so little space and attention to the emerging 'obesity epidemic' and the role that physical activity had, and could continue to play, in combating it. It would now seem even more opportune and appropriate for this investigation to be undertaken, especially for this particularly timely health emergency, but also for other (non-cardiovascular) disease outcomes.

Particularly from a science policy perspective, a deeper and fuller examination of, and comparison between, Key's 'cholesterol campaign' and Blair's moderate activity 'health paradigm' might well yield a host of insights into public health policy making within the wider field of Regulatory Science. In particular, and has already been mentioned, it might be highly rewarding to unravel how, and why a US Surgeon General's report on 'cholesterol and cardiovascular disease' was apparently proposed and explored, but never published.

The scope for directly generalising from the particular case on which this thesis has concentrated may be modest, but the approach to studying the interactions between scientific and policy considerations in public health, which it has employed, may well be applicable in many other contexts. These include, for example, analysis of the way in which the policy dilemma in the United Kingdom in relation to Foot and Mouth disease, as between vaccination or culling of livestock, has been negotiated. Another suitable international candidate for such an approach might focus on the debates about how to respond to the threat of an epidemic of H1N1 swine flu as between vaccination, the use of anti-viral drugs, or the use of neither. Parallels and tangents between the development of public health guidelines in physical activity, and similar guidelines in

nutrition policy, as was touched on briefly in the introductory chapter (Chapter 1), might also be usefully explored.

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